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VOL. 92 FRIDAY, NOVEMBER 22, 1940 No. 2395

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SCIENCE: A Weekly Journal devoted to the Advancement of Science, edited by J. MCKEEN CATTELL and published every Friday by

THE SCIENCE PRESS

Lancaster, Pa. Garrison, N. Y.

New York City: Grand Central Terminal

Annual Subscription, $6.00 Single Copies, 15 Cts.

SCIENCE is the official organ of the American Association for the Advancement of Science. Information regarding membership in the Association may be secured from the office of the permanent secretary in the Smithsonian Institution Building, Washington, D. C.

THE EFFICIENT PARASITE[1]

By Dr. N. H. SWELLENGREBEL

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THE paper I was supposed to read, but did not, in Section V of this congress bore the title, "The Efficient Parasite." I am going to tell you of a highly efficient parasite I came across in the bush-country of Dutch Guiana. But before coming to that, let me first explain to you what I understand by the word "parasite." Once I have made that clear, the other word, "efficient," will need no explanation.

Now, I beg of you, keep this in mind, that I am not going to tell you what a parasite is, but only what I understand this word to signify. It is simply a matter of definition. Many, or all, of you may have an entirely different definition in mind. So all I ask of you is to accept my definition just for argument's sake and for a period of forty minutes. By the end of that time you may reject it without giving it another thought.

[1] Address delivered before the General Sessions of the Third International Congress for Microbiology, New York, September 2–9, 1939.

Well, then, by parasite I understand an organism wholly dependent on another living organism for its food, its shelter and its reproduction. That other living organism, which provides the parasite with board and lodging, including sufficient shelter to carry on its love affairs without awkward disturbances of any kind, is usually called "the host." If the host is to be of any use to the parasite, it ought to be a living host; a dead host is no good. Now, please, keep that in mind: a dead host is not a host any longer. When the host dies, the whole brood of parasites inside or on his body dies with him. I need not give you any examples; you all have them at your fingers' ends.

Now I ought to admit at once that this statement is not always true. A very striking example is offered by the anthrax bacillus. That is an organism which actually thrives on the death of its host. In fact, it could not continue its existence without that death. It

has to kill its victim, otherwise it itself will perish. To this I answer that the anthrax bacillus is not a parasite at all, because it is a free-living organism, staying in the soil for any number of years, the only peculiarity about it being its non-feeding and non-reproducing. Once in a while, maybe at intervals of many years, it indulges in an orgy of feeding and reproducing. In order to do so it needs a host, better call it a victim or a prey. For it is no more a host than the man who is devoured by a lion. The lion lives by the man's death. The anthrax bacillus lives by the cow's death. For if the cow does not die, but recovers, all the bacilli in its body are killed. But the cow's death stimulates the bacilli to produce spores, a thing they did not do when the cow was still alive. These spores, the free-living stage in the anthrax bacillus' life-cycle, enable it to continue to live in the soil, long after its victim's body has been turned into dust.—No, the anthrax bacillus is not a parasite at all, its victim is not its host, but its prey; this bacillus is a *predaceous organism*. There are many predaceous organisms amongst the bacteria, although not in such a striking fashion as the anthrax bacillus. In fact, it is my opinion that bacteria have done a god deal in the way of blurring our conception of what a parasite really is like.

And, in case you think it is all nonsense that I am trying to make you swallow, let me tell you that this bright idea of mine is not mine at all, but that of your great countryman, Theobald Smith, who has invented the conception, and coined the name, of predaceous organisms, as distinct from true parasites.

So I repeat and maintain that the true parasite is dependent for its existence on the life of its host—more than that, on the well-being of its host. And the efficient parasite is the one which has succeeded in keeping well out of harm's way, harm to its host as well as to itself. The efficient parasite lives quietly in a secluded corner. It is frugal and modest in its feeding and in its reproduction. In short, the efficient parasite is a non-pathogenic organism. Such organisms have sometimes been given separate names: symbionts, if they were supposed to benefit the host; commensals, if they were supposed to do him neither harm nor good. All these names are quite superfluous; "efficient parasite" covers them all.

But are there inefficient parasites? Oh, yes, there are. Every efficient parasite may become an inefficient one, by change of surroundings. And the principal and most distressing sign of its inefficiency (both to itself and to its host) is its pathogenicity. I know it will be rather hard for the medical profession to admit this. But if one reflects that, as a broad rule, nobody thinks of looking for parasites in man, unless there is some incentive to take that trouble, *i.e.*, unless some state of ill health does exist, it is not to be wondered at that the conception of "presence of parasites" and the conception of "disease" are inextricably mixed up. So much so, indeed, that the word "infection" (which really means nothing but the presence of parasites in the host's body) is used as a synonym of "disease." The expression "he is suffering from a malarial infection" may either mean that he is suffering from a fever, or that he is simply showing parasites in his blood, the suffering being usually taken on trust.

That is the reason why parasites, as far as human parasites go, are best known in their inefficient state of pathogenicity. It is different in animals, but the study of parasites in animals offers the disadvantage that we are often unable to decide whether the parasite is doing any harm or not. It is impossible to determine the general mortality, the infant mortality, the natality and other vital statistics in a natural population of earthworms or centipedes.

But to return to the efficient and inefficient parasites. There are parasites which are always (or nearly always) efficient, always harmless, like that dweller of our intestinal tract, *Entamoeba coli*. Whether or not there exist true parasites which have found it possible to carry on hampered by an ineradicable habit of killing their host I do not know and am inclined to doubt. But there can be no doubt that there exist parasites which are so pathogenic that they can only save the existence of their species by some contrivance which constantly enables them to jump from one dying victim to a still healthy one, each time, of course, at the loss of thousands of unfortunate individuals which did not succeed in effecting this transition. But even among these apparent incurables, one sometimes comes across specimens which frankly show for once their true parasitic (*i.e.*, non-pathogenic) nature.

I want to tell you of such a find.

Imagine for a moment a medical man, practicing in a malarious area and invariably in the habit of taking bloodslides of all his fever-patients. (In my country such a practitioner is far from common, but that, no doubt, is different here.) You will agree that such a man will be apt to associate any morbid symptoms he detects in his patients with the parasites he finds in their blood. And, as a rule, he will be proved in the right, by the symptoms disappearing in the course of an anti-malarial treatment. Of course I realize that this, sometimes, is a proof of very doubtful value, but let us leave it at that. But this year I visited a country where the otherwise highly laudable practice of making a bloodslide of every patient would lead to the most complete and hopeless confusion and ill-treatment.

But allow me to relate my experience in the proper order of events. Just as an introduction, let me tell you that I stayed in Dutch Guiana for four months in order to study the sanitary possibilities for the settlement of Jews in that part of the wet tropics. I

soon realized that a proper selection of the site for a prospective settlement would have to take account of malaria as one of the major health problems. I do not want to bother you with the various problems I had to face. Sufficient to say that the study of one of these problems carried me to the densely wooded interior of Dutch Guiana. This interior is not inhabited by European or by the colored agricultural population living in the area nearer the coast. There exist no roads leading to those districts and the rivers, which in the coastal country are the great arteries of traffic, are of no use as a means of transport, since they can not be navigated by any craft except the small native boats or *coryals,* owing to the numerous rapids. In these remote areas a purely African population is living, supposed to have been descended from runaway slaves who settled there in the course of the eighteenth century. They are known as bush Negroes. They are entirely different from the Negro population living in the coastal districts. Except on formal occasion they go almost naked, their houses are different, their language is different. Still they are not quite unaffected by European influence, since the Moravian Brothers and the Roman Catholic Church have established a few mission stations along the upper reaches of the Surinam River. Although these missionary efforts have but little influenced their mode of life, they have, in one village at least, which has been completely Christianized, brought about a very accurate registration of the total population, which has been continued for many years. Every individual is registered at birth, again at the time of christening, of marriage and of death. Since there exists little or no intercourse with the outer world, and since the preachers and schoolmasters living among them know every inhabitant by name, this registration of births and deaths may be regarded as fairly reliable, much more reliable than any data I have been able to collect in other parts of the world under more or less similar circumstances.

The areas inhabited by bush Negroes are all known as highly malarious. Malaria exists extensively in Dutch Guiana, along the coast as well as in the interior. But whereas sub-tertian is comparatively rare in the former districts, it is the predominant type of malaria in the bush, often associated with black-water fever. The reason why the unhealthiness of the bush area has become a byword in the colony is not that the bush Negroes themselves are known to suffer severely. The people who suffer are those habitually living in the coastal districts and who penetrate into the interior for the sake of collecting wood, balata or gold. That is the reason why the localities known to be most unhealthy are invariably those where strangers to the bush country assemble in the largest numbers. It is always cases of malaria among police constables, district commissioners and their staff, balata-bleeders or gold-washers, that come to our notice. The bush Negro looms largely in the background, but he is never mentioned specifically. The bush Negro is supposed to be immune to malaria and, according to classical conceptions, to have acquired this immunity by heavy and prolonged attacks from which he suffered in his infancy and to which many of his less fortunate brothers have succumbed; an immunity gained at the price of a heavy mortality, especially infant mortality.

The village to which my attention was directed by the existence of a registration coming as near to vital statistics as could ever be expected in these wild surroundings, did not suffer from such a bad reputation for the simple reason that there were not sufficient strangers to give the place a bad name. Still it richly deserved that name, for all missionary servants who had not previously lived in a malarious area came down with fever after a period of residence ranging from half a month to three months. My own experience corroborates theirs. I had falciparum malaria eleven days after stopping quinine prophylaxis which I had practiced during my stay in the bush.

Among the bush Negroes themselves, malarial fever was of comparatively rare occurrence. During our ten days' stay in the village my assistant, Dr. van der Kuyp, treated nearly 600 people, two thirds of the whole population, which numbers about 900. Out of these, fourteen were treated for malarial complaints, *i.e.,* a little over 2 per cent. of the total number of patients. You will realize how small that number is, when I tell you that it equals the percentage of cases treated for malaria among the patients in that particular district of the coastal area we have selected as the most appropriate spot for Jewish immigration, since the spleenrate among school children hardly exceeds 10 per cent. So, according to that ten days' medical treatment of the greater part of the bush Negro population of that particular village, malaria was of very little importance.

Malariometric examination of about half of the population had an entirely different tale to tell. I feel I must apologize that I did not examine more in this ideal field of research. But when it came to taking bloodslides of adults, toddlers and infants (there was no difficulty in school children), it took a Sunday morning's sermon on the vice of ingratitude in general and the ingratitude of the bush Negroes in particular, and the most direful threats of never getting any more medicine, to induce them to be examined by me.

The result of this examination comprising about 400 people was, by itself, in no way astonishing. It was identical with that which has been found by others, and by myself, among certain groups of Negroes in Africa. Without encumbering you with too many figures, I may say that the spleenrate of infants and

toddlers was well over 80 per cent. It sank to 75 per cent. in younger school children, to 50 per cent. in older school children and, finally, to 15 per cent. in adults, *i.e.*, people of sixteen years and over. The spleenrate, which in Europeans and Asiatics is such a reliable gauge of malarial conditions, proved wholly inadequate to evaluate the extent of malarial infection in this village. For whereas no more than two fifths of the toddlers and three quarters of the younger school children showed splenic enlargement, nearly all of them had parasites in their blood in numbers sufficient to be detected by a three minutes' search of a thick film. The older school children whose spleen showed palpable enlargement in no more than half of the cases had parasites in their blood in three quarters of the lot, and about one third of the adults were infected, although less than one sixth of them showed splenic enlargement. The infants were the only ones to sustain the honor of the spleenrate as a reliable malariometric figure. Their spleenrate almost reached 90 per cent., their parasite rate 80 per cent. only.

All this, I repeat, is nothing new. Similar high figures have been found in other Negro populations. I may point your attention, however, to the fact that they are rare among Asiatic populations, as has been pointed out by Schüffner. In highly permanently malarious areas of the Dutch East Indies, for instance, the spleenrate in school children and adults maintains the high level which it reached in toddlers, but the parasite rate never attains to the tremendously high levels we see in heavily and permanently infected Negro populations. Moreover, it drops to a very low level in adults.

The figures I quoted, however, claim especial interest if we remember that this was the same population which, at the time of the examination, was paid an unwonted visit by a medical man whose open-air surgery was crowded every day for ten days, to whom people came for all manner of complaints from which they, their children, their toddlers, their infants were suffering. And from that population, with all its eagerness for treatment, we did not succeed in collecting more than a paltry fourteen fever-patients.

Of course, it might be objected that the statement of three fourths of the infants and nearly all the toddlers and younger school children being infected with malaria parasites does not greatly impress one so long as one does not know how many parasites they were carrying at the time of examination. It is all very well to say that these children apparently were in excellent health, although they were parasite carriers. But if "being a parasite carrier" simply means that a few parasites were found after three minutes' search, it is not so difficult to believe that they were not actually ill at the time of examination. To meet this objection let me tell you that about four fifths of the infants and the toddlers carrying parasites had at least one parasite for every ten leucocytes, a number amply sufficient to render any man of, say, my stamp thoroughly miserable, all the more so since the majority of infections are falciparum. But those brats did not care a bit!

No, they did not care a bit within that period of ten days. But that is only a snapshot. But how did they fare later on? I can not tell you. But I can tell you how they fared earlier in the year and in the preceding years. And since this year was in no way abnormal, from a health point of view (as the local European nurse, stationed there for over four years, assured us), we may assume that malaria infection was normal too. Well, in the year preceding our investigation, the general mortality in that bush Negro village was 16 per thousand, the natality 34 per thousand and the infant mortality 71 per thousand infants born alive. Over the last twelve years (from 1927–1938) the general mortality was 21 per thousand and the infant mortality 107 per thousand. These are figures which would not show well in a proud American city or, if I may say so with some satisfaction, in a town like Amsterdam. But even as late as 1919 infant mortality over the whole of the Netherlands ranged still over 90 per thousand. So we may conclude that high and constant malarial infection to which these bush Negroes are subjected not only leaves the adults unaffected but does little harm even to the youngest children. At any rate, we are in that village far away from that condition of immunity in adults, described to be attained over the corpses of thousands of young children. Allow me to repeat that this description is absolutely correct. Such conditions do exist. But not among these bush Negroes.

And how to return to the point from which I started —the efficient parasite. I suppose you have, by now, gathered what I mean by this word. Plasmodium falciparum, vivax, malariae, they all are efficient parasites in the collective bodies of that bush Negro population. Certainly things did not proceed as smoothly as might have been expected from ideally efficient parasites. There is some struggle, as exemplified by the splenic reaction in children, which even in adults has not quite subsided. And the heavy drop in the number of parasites per carrier (in adult carriers more than nine tenths have less than one parasite per 10 leucocytes) also shows that the parasites pay for the benefit of continuing in the adult human host by strictly enforced birth control. All the same, compared with the interaction of the parasite and the white human host, we may safely conclude that the parasites in the bush Negroes are fairly efficient and that there is little likelihood of extinction of either species, man or plasmodium.

But what one may well ask is this. Who deserves

the epithet "efficient"—the parasite or the host? Had not the title of the paper better be "The Efficient Host"? In this case this is undoubtedly true. These same parasites which behaved in such an exemplary manner in the bush Negro's body, behaved very badly in my own. It is the bush Negro's body which, first by refusing to be killed, and afterwards by a judicious and not too far carried reduction of the number of parasites, finally obtains that nicely adjusted equilibrium which does not even require the intervention of the spleen. Nevertheless, I maintain the parasite's claim to the title of "efficient" since it allows itself to be domesticated in this way.

So we come to this conclusion. If we see a parasite behaving as it should behave—not harming its host and, as a consequence, not harming itself—in short, if we see it behaving as an efficient parasite, we know that this is the outcome of an interaction between host and parasite of a struggle in which both have had to sacrifice something. The host has had to get rid of his over-sensitiveness, he has had to become tolerant of the parasite's presence in his body. And the parasite has had to suffer a considerable reduction in its procreative powers. It is an adaptation of the host to a greatly subdued parasite. The Negro body, better than the body of most human beings, seems extraordinarily well fitted to pass unscathed through the various stages of this adaptation.

And now, finally, you will allow me to say something on the subject which I have had in mind these last five months: the settlement of political refugees in the tropics, more especially in the Guianas. It has little to do with the efficient parasite but a great deal with the propensity of the African race to act as a highly efficient host of the malaria parasites.

Up till now the importance of this peculiarity of the African race has been underrated because many of the greatest authorities have refused to regard it as a racial quality by which the African races fundamentally differ from other races. Every race can acquire some measure of immunity to malaria. The African race, together with a few obscure hill-tribes in India, are the only ones to be born with it.

I need hardly emphasize that this racial quality affords the Africans a considerable advantage over the other races in the case of the interracial struggle for existence developing in an environment in which malaria plays an important part. I am not going to enlarge on this subject which would completely carry me away from the beaten track I am following. To those who wish to reflect on this remark of mine, I would recommend the perusal of Grenfell Price's book on "White Settlement in the Tropics," recently issued by the American Geographical Society. Notably, his remarks on the fate of the white race in some parts of the tropical world are worth reading in this connection.

But this I would say. Any attempt at settlement of whites in areas where malaria is rife and where, by the conditions under which the settlement is organized they will have to compete with the African race on a footing approaching equality, is bound to be a cruel failure unless malaria has been reduced to insignificance before the settlement is started or unless an enforced segregation is rigorously applied to keep the two races so much apart that there can be no longer any competition between the two.

I realize that my address has been somewhat out of tune with the highly cultured scientific sphere of this congress, where the serene atmosphere of the laboratory and the lecture room prevails. I came here directly from the wilds. The field has been my laboratory for months and I have consorted more with bush Negroes and Indians than with cultured people. Moreover, I can not get rid at a moment's notice of the ideas and interests which have occupied my mind since I left Holland and which, although of little importance in the present circumstances, are bound to clamor for notice at some future date. Accept my address as a contribution to the vexed question of the host-parasite relationship. That I did not quite succeed at the end in keeping away from the subject I have very much at heart must be regarded as an amiable mental aberration comparable with that from which one of Charles Dickens's famous characters of fiction suffered when he never succeeded in keeping King Charles' head out of the Memorial he was writing. If I had had Mr. Dick's unlimited time at my disposal I would have torn up this memorial to write another one. Since I had not the time, I had to offer it to you as it is.

THE KINETICS OF CONTACT CATALYSTS AND THE INDUSTRIAL BACKGROUND[1]

By Dr. HUGH STOTT TAYLOR

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IT is a tragedy of the efforts of the student of chemical reactions at surfaces, in these closing decades of the two centuries of service to culture and civilization that the University of Pennsylvania is now celebrating, that the finest flowers of the effort should have synchronized with and been made subservient to the inter-

[1] Read at the Bicentennial Conference of the University of Pennsylvania, September 17, 1940.

national tragedy of 1914–1918 and that which now burdens the human race. It was not mere accident that, in the decade preceding the first Great War, out of the fundamental researches of Sabatier on the capacity of nickel and other metals to induce the combination of hydrogen with unsaturated substances, there emerged the answer to the famous query of Napoleon to his French scientists one hundred years earlier as to the possibility, in a blockaded country, of converting liquid fats into the solid fats necessary for the production of margarine and of soaps. It was a proud boast of an English technician in 1919 that they had succeeded in converting fifth-grade whale oil into edible fats in the last years of the first World War. It can not be chance alone that the industrialization of Haber's researches on the fixation of atmospheric nitrogen and the production of the ammonia necessary for fertilizers and explosives should have been achieved on the eve of that same war which found Germany cut off, by British sea-power, from the only hitherto available source of fixed nitrogen, the nitrate deposits of Chile. These processes demanded in their turn cheaper sources of hydrogen. This was achieved by new processes of formation at catalytic surfaces and put to use for the filling of those now archaic "sausage balloons" that served as observation posts on the battle lines of Flanders. To-day it is the "barrage balloons" that use hydrogen to protect areas against the invasions of invading bombers.

Two decades of "progress" demanded the solution of new problems for the coming new war. The mechanization of transport has profoundly modified the technique of modern warfare. The present distribution of sea-power compelled a blockaded country to ensure for herself either accessibility to the necessary raw materials of transport such as oil and rubber or alternatively so to shape her technological development as to insure the production of such materials synthetically from raw materials available within the blockaded area. Within Germany during the last years there have been developed, by means of reactions at surfaces, methods of converting coal into high quality aviation gasoline and synthetic rubber materials which have gone far towards making that country independent of supplies from abroad. Similarly, her need for fats, mitigated in part by her conquests of the present year, demanded the replacement of the fats used in soap manufacture by synthetic detergents and the development of methods for the conversion of available raw materials into synthetic fatty acids. Marked progress has been achieved in these directions.

Even in the case of countries open to the available resources of nature it has been found that nature does not always produce the most highly desirable forms of the materials to be consumed. Petroleum supplies an excellent example of such a situation. In the early days of the automobile, adequate fuels could be obtained by simple distillation of crude oil. Improvements were demanded by increasing fuel requirements which led to the development of cracking processes for increasing the gasoline fraction from a given barrel of crude. The demand for increased power in the automobile, stimulated further by progress in aviation, led to the realization that certain types of gasoline molecules, notably iso-octane, possess fuel characteristics that far exceed those of other molecules within the range of volatility demanded by the engines in question. New problems were thus presented to the chemist, the conversion of low-grade natural products into the more valuable high-grade fuels. In the solution of these problems the catalytic chemist has made notable contributions. Catalytic methods have been developed for cracking complex petroleum molecules into simpler high-grade automobile and aviation fuels, for polymerizing or putting together the simpler hydrocarbon molecules to form molecules of high anti-knock value in the gasoline range, for adding simpler saturated molecules to unsaturated molecules to form valuable fuels, the so-called processes of catalytic alkylation; catalytic isomerization, the changing of molecules of a given configuration to other configurations more powerful in fuel characteristics, catalytic dehydrogenation, which, coupled with catalytic processes of ring formation, lead to the formation of aromatic fuels containing benzene, toluene and xylene. As a by-product of these latter new processes of dehydro-aromatization the petroleum industry is becoming an active competitor of the by-product coke oven industry upon which, hitherto, we have been dependent entirely for the raw materials of the dyestuff industry, explosives and many pharmaceutical preparations.

Paralleling in intensity these developments with the more complex units of petroleum raw materials a series of efforts have evaluated the lighter constituents of petroleum, natural gas and the cracked gases of refinery operations. Catalytic processes have been developed for the direct oxidation of ethylene at metal surfaces, notably silver surfaces, to yield ethylene oxide, itself a reagent of great value in a series of synthetic processes and the intermediate in the production of ethylene glycol, a product now required on a tonnage basis for anti-freeze solutions. Propylene, the next higher unsaturated olefinic hydrocarbon, is by reason of a newly developed process, the raw material for synthetic production of glycerine available at any moment when the by-product glycerine of soap manufacture becomes inadequate to meet the demands. Butene, a four-carbon atom olefine, yields by further catalytic removal of hydrogen the butadiene which is the start-

ing material for the synthetic rubbers of the Buna-types developed in Germany. There, due to lack of petroleum, coal is the raw material and the production of butadiene occurs via the formation of calcium carbide and acetylene. That butadiene, under the influence of metallic sodium, would polymerize to a rubber-like material has been known since the end of the last century. It was such materials which were employed as rubber substitutes by the Germans in the latter phases of the last war. The progress achieved in the recent researches arises from the discovery that "cross-polymerization," the introduction of other molecules into the growing unit, rubber, like the plastics, cellulose, starch, etc., being "macro-molecular," that is, composed of large numbers of constituent units combined with each other into a structural pattern conferring on the mass its particular characteristics. The newer synthetic rubbers build into the growing butadiene polymer such other materials as styrene and acrylic nitrile with the result that products having abrasion characteristics and resistance to oxidation, and therefore to deterioration, are from 5 to 30 per cent. better than the best natural rubbers that have been produced. Superior characteristics over the natural products also obtain in the case of such special products as neo-prene and thiokol, which, in addition to their carbon and hydrogen constituents, contain also chlorine and sulphur respectively, thus deviating markedly in constitution from the natural product, possessing properties which for certain purposes render them more valuable than the natural product.

In the field of plastics also the chemistry of reactions at surfaces is making notable contributions. These materials have almost endless uses and possibilities alike for peacetime and war uses. They can be used as substitutes for metals and for glass. Optical instruments, aeroplane parts, possibly even impregnating material for ply-wood aeroplane wings are among their immediate uses in the era of defense now upon us. Solvents for plastics, ethers, alcohols and esters are allied materials that the catalytic chemist is contributing. From these researches also stem the newer synthetic fibers of which nylon as a material superior in many characteristics to silk is now in large-scale production. The raw materials from which they are made, coal, limestone, petroleum, water and air require the chemistry of reactions at surfaces for the transformations that ultimately yield the desired products.

America can face the intense competition that rages in this field with equanimity. Thanks to her universities and the large bodies of trained personnel which they have turned out American chemical industry finds itself to-day in a vastly more favorable position, when national emergency once more confronts her, than 25 years ago. During this quarter of a century the industry has grown from the tiniest of infants to a giant, has seized the initiative from all competitors and potentially can outstrip them all. Side by side with the intensive industrial developments here outlined there has grown up also in industrial research, governmental and university laboratories a broad program of theoretical study in this field. Upon the pioneering investigations of Langmuir has been built a body of theoretical fundamental knowledge, the major contributions to which have come from American laboratories, and with the aid of which a more rapid and certain approach to the solution of problems of industry can be achieved. Langmuir recognized that the seat of chemical change at surfaces was a layer of absorbed gas one molecule thick associated with the surface by chemical forces. The heterogeneity of catalytic surfaces was then recognized and its importance in the interpretation of the great sensitivity of surfaces to poisons became understood. This concept led also to an understanding of the phenomenon of promoter action whereby, with suitable added material, the efficiency of a given quantity of catalyst material could be enormously enhanced. The quantitative extent of the surface could be increased and its quality multiplied. Later researches revealed that two types of association of a gas with a surface, the one physical, the other chemical, could obtain and that the operating temperatures determined which type of interaction occurred. With different surfaces, different temperature ranges could be employed. The range of catalytic materials and the temperature ranges in which they operate were correspondingly expanded. With the advent of isotope separations, signalized by Urey's discovery of heavy hydrogen, followed by heavy oxygen, carbon, nitrogen and sulfur, new tools became available for the study of the associations with surfaces involved in catalytic changes. To-day the analysis is going yet deeper. With the modern tools of x-ray and electron diffraction the catalytic chemist is examining the activities of individual faces of crystals and is demonstrating that the geometrical configurations characteristic of particular faces are more favorable to the activation of reactants than are other faces. As a consequence methods can be developed to produce the desired crystal faces in preponderant amount. Twenty-five years ago the science of catalysis was almost purely empirical, dependent entirely on trial and error. As the University of Pennsylvania enters upon its third century of intellectual effort, the chemistry of reactions at surfaces has become a highly refined scientific study, rich in possibilities for applied science and in joyous endeavor for the fundamental scientist.

SCIENTIFIC EVENTS

THE AUSTRALIAN COMMITTEE ON ANIMAL PRODUCTION

THE *Australian Journal of Science* in an account of the Constitution and Work of the Australian Committee on Animal Production states that at the invitation of the Commonwealth Government, Dr. J. Hammond, of the Animal Nutrition Research Institute of the University of Cambridge, visited Australia in the autumn of 1938. He has submitted a report on the conditions of Animal Production in Australia, making the following recommendations:

> The major problems of the Australian Meat Board, the Australian Dairy Produce Export Board and the Australian Wool Board, are of general Commonwealth concern, and it would appear that the progress of the animal industry in Australia could best be served if an Advisory Committee of the Council for Scientific and Industrial Research comprising representatives from these Boards, the Council, the Department of Commerce and Standing Committee on Agriculture, could be set up to make suggestions concerning work to be done in animal production, to accept responsibility for conducting the scientific work fundamental to the industry, and to coordinate the technical work going on in the different states through the research officers suggested above or by other means agreeable to the states.

This recommendation, according to the journal, sounded a rallying note welcomed by most of the bodies in question, so that at a meeting held in Melbourne and convened by the Australian Meat Board, representatives of all the State Agricultural Departments, the Australian Meat Board, the Australian Dairy Produce Board and the Council for Scienitfic and Industrial Research agreed that the establishment of such a committee would be advantageous.

The proposed body has become the Australian Committee on Animal Production. Its chairman is the Hon. H. S. Henley, a member of the Australian Meat Board. Its members are Dr. A. E. V. Richardson and Dr. L. B. Bull, of the Council of Scientific and Industrial Research; W. J. Spafford, director of agriculture, South Australia; A. H. E. McDonald, of the Department of Agriculture, New South Wales; G. K. Baron-Hay, of the Department of Agriculture, Western Australia; F. W. Hicks, of the Department of Agriculture, Tasmania; H. A. Mullett, director of agriculture, Victoria; Professor Seddon, representing the Queensland Department of Agriculture; Ross Grant, of the Department of Commerce, and J. Proud, of the Australian Dairy Produce Board. A. J. Vasey, of the Division of Animal Health and Nutrition, Council for Scientific and Industrial Research, is secretary.

The Animal Production Committee early appointed technical subcommittees to which were referred for consideration the report of Dr. Hammond and that of J. M. Coleman upon Fat Lamb Production in Australia.

There were five of these technical subcommittees, each of which dealt with a branch of animal production. These subcommittees dissolve automatically after their reports have been submitted.

THE DUTCH ELM DISEASE IN CONNECTICUT

DESPITE federal, state and local efforts to check the Dutch elm disease in Connecticut, the Agricultural Experiment Station at New Haven reports slow but steady increase and spread in 1940. Fourteen new towns were brought into the zone of infection as a result of summer scouting. One diseased tree was found at Preston, thirty miles from the nearest point of infection. Nevertheless efforts to save the elms continue —the federal work through the Dutch elm disease office of the U. S. Department of Agriculture, and state work through the Experiment Station, represented by Dr. Roger B. Friend, state entomologist.

Altogether, Connecticut has found 1,686 cases of Dutch elm disease since the infection first appeared there in 1933. Many of the 378 diseased elms found last summer occurred outside the areas of infection. In general the spread was from adjacent towns where the disease had been found previously. The point of infection nearest to Preston, however, is Old Lyme, 30 miles away, where the last case appeared in 1937. Old Lyme lost seven trees in three years. At that time stringent measures were taken to destroy all dead and dying elms or parts of elms that might attract elm bark beetles, carriers of Dutch elm disease. Apparently the job was thorough since no more cases have been found in the vicinity.

During 1940 the U. S. Department of Agriculture has been responsible for scouting, elm sanitation and clean-up work in the state. Through its legal authority to carry on projects on private property when necessary, the Experiment Station cooperates with the federal agents by obtaining this permission for them. The station also is engaged in research, seeking a possible cure or control for the disease. This has involved an intensive study of the elm bark beetles and the materials that might repel or kill them, and the use of chemicals in disease control. So far no spray has been found that will prevent beetle feeding in the crotches of elms. However, creosote treatment of felled timber keeps them from breeding under the bark.

When trees showed outward symptoms of the disease, wilting and yellowing of foliage on terminal

twigs, the scouts took samples for further examination. Any that showed the characteristic dark streaking under the bark were sent to the federal laboratory at Bloomfield, N. J., for culture. Specimens from elms in territory never before infected were also cultured at the Experiment Station. All those found diseased have been removed and burned so that beetles under their bark can not carry infection to healthy elms.

During the cold months the federal men will engage in elm sanitation work. This consists of looking for elm material infested by bark beetles and material which may be attractive for beetle breeding next spring. When it is necessary to remove trees, owners have the choice of cutting the wood and storing it in an approved manner, or of turning the job over to the government completely. Logs may be stored in tight cellars or bins from which the beetles can not escape, or debarked and left outdoors. The federal method is to burn all the elm wood.

EXPEDITION TO THE BADLANDS OF SOUTH DAKOTA

ACCORDING to a bulletin of the National Geographic Society, after three months spent in prospecting and in excavating fossil bones in the Badlands of South Dakota, an expedition, sent out jointly by the National Geographic Society and the South Dakota State School of Mines, has completed its season's work with an unusually large and valuable collection of specimens. The one hundred and seventy-five or more specimens, weighing several tons, are now at the School of Mines in Rapid City, S. D., where the work of preparing and mounting them for exhibition is being carried on. Preliminary investigations indicate that they include several species and genera new to science. Probably included in that category will be a rhinoceros represented by a skull twenty-eight inches long, and a pig (also represented by a skull) which, when alive, measured fully eight feet from snout to tail.

Among other specimens found by the expedition were fossil bones of tapirs, little three-toed horses (the remote ancestors of present-day horses), protoceros (remotely related to deer and antelope), the little-known ancodus and a number of small rodents. Rarest of the specimens are bones of birds—only a few have previously been found in the Badlands. The principal find in this group was a fossil egg still firmly held in its matrix of rock. A few plant fossils were found of fossil hackberry seeds and petrified hackberry wood.

The expedition, led by Dr. Joseph P. Connolly, president of the School of Mines, and James D. Bump, curator of the School of Mines Museum, including seven other members, established camp in an eroded region twenty-five miles from the nearest highway. Its work was carried on in the summer sunshine where mid-afternoon temperatures frequently reached 120 and 130 degrees Fahrenheit. Some of the heaviest specimens were found near the tops of high, slender pinnacles and had to be lowered by block-and-tackle.

The material collected by the expedition is particularly rich in rare specimens because the work was confined to geological formations in which very little work had been done heretofore. These are the Channel Sandstones, so called because the beds were formed by deposits filling stream channels worn in the clay surfaces in Oligocene times, probably thirty million years ago. The surrounding clay—now turned to shale—is softer and much more easily worked, and from it have come most of the specimens previously collected.

PORTRAITS OF DISTINGUISHED CHEMISTS

The News Edition of the American Chemical Society states that "Portraits of Distinguished Chemists," published by the *Journal of Chemical Education,* consists of reprints of particularly important frontispieces which have appeared in the journal from time to time. These pictures, carefully printed on the finest grade of coated paper, in addition to their chemical interest have an artistic quality that entitles them to a place in a living room or library.

"There are 48 portraits, divided into three series of 16 each, printed on separate sheets, 8 by 10.5 inches in size, and similar in every respect. Their instructive value is increased by descriptive legends stating the important facts of each man's career, his dates and reference citations. These legends are visible when the portraits are framed."

Each series is enclosed in a portfolio of deep red cover stock on which are printed the names of the chemists whose portraits it contains. A list of these names follows:

SERIES A

Svante Arrhenius, Adolf von Baeyer, M. Berthelot, Robert Boyle, Stanislao Cannizzaro, Madame Curie, J. H. van't Hoff, Michael Faraday, H. Le Châtelier, Justus von Liebig, Dmitri Mendeléeff, Louis Pasteur, Sir William Perkin, Joseph Priestley, Sir William Ramsay, Friedrich Wöhler.

SERIES B

Francis W. Aston, Robert W. Bunsen, James Mason Crafts, John Dalton, Emil Fischer, J. Willard Gibbs, W. F. Hillebrand, Irving Langmuir, Henri Moissan, Walther Nernst, Wilhelm Ostwald, T. W. Richards, Benjamin Rush, Paul Sabatier, Benjamin Silliman, Benjamin Thompson.

SERIES C

Joseph Black, Herman Boerhaave, Irène Joliot Curie, Sir James Dewar, Victor Grignard, Fritz Haber, Charles

M. Hall, Robert Hare, Frédéric Joliot, Achille Le Bel, M. V. Lomonósov, Bernard Palissy, C. F. Schönbein, Paul Schutzenberger, Edgar Fahs Smith, Harvey W. Wiley.

LECTURES TO THE LAITY OF THE NEW YORK ACADEMY OF MEDICINE

THE sixth Series of Lectures to the Laity of the New York Academy of Medicine opened on November 14 with a lecture by Dr. Alan Gregg, director of the Medical Sciences of the Rockefeller Foundation, which was presided over by Dr. Malcolm Goodridge. Dr. Gregg pointed out that "the history of humanism shows that it began in protest at too much preoccupation with theology. The potential role of humanism to-day is to carry man, and especially the physician, beyond the limitations of natural science."

Other lectures in the series are as follows:

December 12, 8:15 P.M. Psychiatry and the Normal Life, by William Healy, M.D., director, Judge Baker Guidance Center, Boston. To what extent should the normal man be educated in psychiatric understandings for the sake of better management of himself and the advancement of civilization? *Presiding chairman,* Nolan D. C. Lewis, M.D.

January 23, 8:15 P.M. Paracelsus in the Light of Four Hundred Years, by Henry E. Sigerist, M.D., director of the Institute of History of Medicine, the Johns Hopkins University. Paracelsus was not only one of the greatest physicians of the Renaissance but also one of its great philosophers. His courageous and original approach to the problems of life and death, health and disease, physician and patient, gave him a unique position in the medical world and to-day, four hundred years after his death, he still brings us a significant message. *Presiding chairman,* Alfred E. Cohn, M.D.

February 27, 8:15 P.M. What We Do Know about Cancer, by Francis Carter Wood, M.D., director of Radio Therapeutic Department, St. Luke's Hospital, New York City. A review of the vast amount of research work on animals and of the clinical investigations of cancer, by the newer methods, which have yielded a large amount of knowledge, much of which is still unfamiliar to the layman. *Presiding chairman,* C. P. Rhoads, M.D.

March 27, 8:15 P.M. Philosophy as Therapy, by Irwin Edman, Ph.D., professor of philosophy, Columbia University. The possible union of empirical psychiatric investigation and the delicate insights of philosophical analysis. Philosophy may still have medicinal uses, and medicine itself may gain by the techniques and perspectives provided by philosophical discipline. *Presiding chairman,* Eugene H. Pool, M.D.

April 24, 8:15 P.M. The Promise of Endocrinology, by Oscar Riddle, Ph.D., Carnegie Institution of Washington, Department of Genetics, Cold Spring Harbor, N. Y. What is known about the regulation of body functions by hormones. The use of purified hormones in maintaining health and in combating disease. *Presiding chairman,* David Marine, M.D.

RECENT DEATHS AND MEMORIALS

DR. RAYMOND PEARL, professor of biology in the School of Medicine and in the School of Hygiene and Public Health of the Johns Hopkins University, died suddenly on November 17 at the age of sixty-one years.

DR. OLIVER THOMAS OSBORNE, emeritus professor of therapeutics at the Medical School of Yale University, died on November 11 at the age of seventy-eight years.

ELNATHAN KEMPER NELSON, senior chemist in the Food Research Division of the Bureau of Chemistry and Soils of the U. S. Department of Agriculture, with which he had been connected for thirty years, died on November 10 in his seventieth year.

DR. OTTO E. PLATH, entomologist and professor of biology at Boston University, died on November 5 at the age of fifty-five years.

GRACE A. SANDHOUSE, since 1926 a specialist in the identification of bees and wasps in the Bureau of Entomology and Plant Quarantine, died on November 9 at the age of forty-four years.

IN recording the death of Dr. Carl Alsberg, it was said that he was director since 1937 of the Giannini Foundation of Stanford University. It should have been said that since October, 1937, he was director of the Giannini Foundation of Agricultural Economics of the University of California at Berkeley. Previously, he was director of the Food Research Institute at Stanford University.

THE *Journal* of the American Medical Association states that a Mayo Memorial Commission has been appointed by Governor Harold E. Stassen, of Minnesota, to study a proposal for the establishment of a fund of $250,000 through public subscription throughout the world for a memorial to the late Drs. William J. and Charles H. Mayo. State Senator William B. Richardson, of Rochester, is chairman of the commission, which is composed of seventeen representative citizens of Minnesota.

SCIENTIFIC NOTES AND NEWS

THE Rudolf Matas Medal for vascular surgery of the School of Medicine of Tulane University was presented on November 14 to Dr. Daniel Collier Elkin, professor of surgery at Emory University, Atlanta.

THE Collier Trophy, presented annually since 1911 for achievement in aviation, has been awarded to Dr. Walter Boothby and Dr. W. Randolph Lovelace, II, of the Mayo Clinic, Rochester, Minn., and to Captain

Harry Armstrong, of the Army Medical Corps, for their researches on the effect on the brain, nerves, blood and reflexes of an aviator when he ascends to the stratosphere.

AT the sixtieth annual dinner on November 1 of the Associate Alumni of the College of the City of New York, which was given at the Hotel Biltmore, five Townsend Harris medals and four Alumni Service medals were presented to alumni of the college for "notable achievement." Among the recipients of the Harris medals were Dr. Alexander O. Gettler, professor of toxicology at the Medical College, and Dr. Louis I. Dublin, vice-president of the Metropolitan Insurance Company. Among the speakers at the dinner were Sir Norman Angell, the British economist, and Dr. Stephen Pierce Duggan, director of the Institute of International Education, New York.

THE gold medal of the Holland Society, awarded each year to "a man prominent in the arts, sciences or humanities," was presented at a dinner of the society on November 14 to Henry Ford in recognition of "his achievements in introducing and developing the art of mass production in industrial manufacture."

AT a meeting of the trustees on November 19 the department of anatomy of the New York Medical College was named the "William Waldo Blackman Laboratory of Anatomy." Dr. Blackman is an alumnus, formerly professor of anatomy at the college, and at present vice-chairman of the Board of Trustees. Professor William K. Gregory, of the American Museum of Natural History, delivered the address of the evening on "Evolutional Causes of the Misery of Mankind." Dr. C. E. Tharaldsen, professor of anatomy, presided over the ceremonies at which President C. A. Burrett, Clifford Hemphill and Dr. Charles E. Birch, of the Board of Trustees, paid tribute to Dr. Blackman.

DR. JAMES FRANCK, professor of physics at the Johns Hopkins University, will give the Hitchcock lectures at the University of California at Berkeley during March. As already announced in SCIENCE, Dr. Walter B. Cannon, George Higginson professor of physiology at Harvard University, will lecture on the Hitchcock Foundation in February.

DR. RALPH IRVING LLOYD, Brooklyn, N. Y., has been named president-elect of the American Academy of Ophthalmology and Otolaryngology, which met at Cleveland from October 6 to 10. Vice-presidents elected are Drs. Everett L. Goar, Houston; James M. Robb, Detroit, and Ralph O. Rychener, Memphis. Dr. Frank R. Spencer, Boulder, Colo., will be president during the coming year.

OFFICERS of the Council on Dental Education of the American Dental Association for the coming year are: *Chairman,* Dr. Minor J. Terry, secretary of the New York State Board of Dental Examiners, and *Vice-chairman,* Dr. J. Ben Robinson, of the Baltimore College of Dental Surgery.

THE list of officers of the Society of American Bacteriologists given in the issue of SCIENCE for November 8, p. 425, referred to the New York branch of the society, not to the national organization.

AT Harvard University, promotions to the rank of associate professor have been announced as follows: Dr. Edward S. Castle, physiology; Dr. George L. Clarke and Dr. John H. Welsh, Jr., zoology.

GERALD M. RIDENOUR, associate in water and sewage research at the New Jersey Agricultural Experiment Station and assistant professor in the Department of Water Supplies and Sewage Disposal at Rutgers University, has become associate professor of sanitary engineering at the Pennsylvania State College.

DR. JOHN A. CAMERON, assistant professor of zoology, has been appointed assistant professor of anatomy at the Medical School of the University of Missouri, to succeed Dr. L. J. Wells, who has been appointed associate professor of anatomy at the Medical School of the University of Minnesota.

DR. WILLIS L. TRESSLER, of the department of biology of the University of Buffalo, has been appointed assistant professor in the department of zoology of the University of Maryland, where he will be associated, also, with the Chesapeake Biological Laboratory as planktologist.

DR. DOROTHY DAY, professor of botany at Smith College, has leave of absence for a year, which she plans to spend at the New York Botanical Garden working in the laboratory of Dr. William J. Robbins, director of the garden.

THE Committee on Scientific Research of the American Medical Association has made grants as follows: to Dr. Arthur M. Lassek, professor and chairman of the department of anatomy at the Medical College of the State of South Carolina, for his investigation of the pyramidal tract in man and other higher primates; to Dr. Harry Beckman, of the School of Medicine of Marquette University, in partial support of the renewal for another year of his studies in the prophylaxis of avian malaria, and to Dr. Wesley W. Spink, assistant professor of medicine at the Medical School of the University of Minnesota, to support an investigation of antistaphylococcal immunity and the nutritional requirements of staphylococci. Dr. Spink has also received a grant from Merck and Company in support of a study of ascorbic acid.

DR. RAYMOND L. DITMARS, of the New York Zoolog-

ical Park, has been appointed curator of the department of insects which will be established at the garden in the spring. Permanent and seasonal exhibits are planned. Dr. Ditmars will relinquish the active curatorship of the department of mammals which he holds in addition to that of reptiles, in order that he may devote more attention to the new branch.

DR. JOSEPH W. BARKER, dean of the School of Engineering of Columbia University, has been named regional adviser for New York and Long Island in the Federal program to train men quickly for engineering work in the defense industries.

DEAN ALEXANDER S. LANGSDORF, of the Schools of Engineering and Architecture of Washington University, St. Louis, has been named regional adviser of the Engineering Defense Training program. He will visit industrial plants in Missouri, Kansas, Arkansas, Oklahoma and West Tennessee to determine what help is needed from engineering schools in obtaining men for work in connection with the defense program and will ascertain what courses in the schools are available and what the cost will be. The Government will bear tuition expenses. Dean R. A. Seaton, of the Kansas State College, who was succeeded as regional adviser by Dr. Langsdorf, has been made national chairman of the program.

DR. BOSTWICK H. KETCHUM, associate in marine biology at the Oceanographic Institution at Woods Hole, Mass., sailed on November 15 for Bermuda to study the effect of bacterial slime on the fouling of ships' bottoms.

DR. OLIVER S. ORMSBY will deliver the presidential address at the twenty-fifth annual meeting of the Institute of Medicine of Chicago to be held at the Palmer House on the evening of December 3. He will speak on "Pellagra." The annual dinner and business meeting of the fellows will be held preceding the lecture when citizen fellowships will be conferred.

DR. CHARLES H. BEST, professor of physiology at the University of Toronto, will deliver the second Harvey Society Lecture of the current series at the New York Academy of Medicine on November 28. Dr. Best will speak on "Thrombosis and the Action of Heparin."

PROFESSOR A. N. RICHARDS, chairman of the Local Committee of Arrangements of the recent meeting of the National Academy of Sciences at the University of Pennsylvania, writes: "I beg to request that you publish the fact that the communication entitled 'Artificial mixing of incompatible germ-plasms in Drosophila,' read by Dr. Hermann J. Muller before the National Academy of Sciences at its autumn meeting on October 28, published in abstract on page 418 of the issue of SCIENCE for November 8, 1940, was a joint communication by Professor Muller and Dr. G. Pontecorvo. The omission of Dr. Pontecorvo's name from the final program was the result of a regrettable oversight."

THE United States Civil Service Commission, Washington, D. C., wishes to secure professional physicists to fill positions in connection with the national defense program of the Federal Government. These positions include the following grades: Physicist (any specialized branch), $3,800 a year; also principal, $5,600; senior, $4,600; associate, $3,200; assistant, $2,600 a year. Applications must be filed with the Commission's Washington office not later than December 12. Applicants for all grades must have completed a 4-year college course; for the three higher grades they must have completed at least 24 semester hours in physics. In addition, for all grades, applicants must have had professional experience in physics. Substitution of graduate study in a specialized branch of physics may be allowed for part of the experience. Applicants for the two lower grades will be given a written test on general and professional questions. No written test is necessary for the higher grades. Candidates will be rated on their qualifications as shown in their applications and on corroborative evidence.

THE Committee on Scientific Research of the American Medical Association invites applications for grants of money to aid in research on problems bearing more or less directly on clinical medicine. Preference is given to requests for moderate amounts to meet specific needs. Application forms may be obtained from the Committee at 535 North Dearborn Street, Chicago, Illinois.

ORIGINAL unpublished essays on any subject in the field of plants useful to man are eligible for the Walker Prize competition for 1941. Further information may be had from the Secretary, 234 Berkeley Street, Boston. The closing date is May 1, 1941.

THE funds for a fellowship of $2,000 to enable Latin American physicians to pursue graduate studies at Mount Sinai Hospital in any of the clinical or laboratory departments have been provided by the Dazian Foundation for Medical Research.

FACILITIES of the department of mathematics of the University of Cincinnati for research studies centering on special problems of aviation have been offered to the United States Army Air Corps staff at Wright Field, Dayton. The offer is an outgrowth of a survey of the research facilities and personnel of the university in the field of the physical sciences and mathematics which Professor Louis Brand conducted during the summer at the request of the National Research Council.

DR. RICHARD B. GOLDSCHMIDT, professor of zoology at the University of California at Berkeley, has presented to the university a collection of letters from eminent biologists of the twentieth century. The letters form part of correspondence with Dr. Goldschmidt. The collection does not contain complete sets of the correspondence, as a large part of Dr. Goldschmidt's files were destroyed when he left Germany in 1936.

THE exhibits, on science, agriculture and education, prepared by the University of California for the Golden Gate International Exposition in San Francisco, valued at $80,000, have been presented to the university by the California Commission, a body created by the Governor to aid the Exposition. The exhibit "Science in the Service of Man" was prepared by the university with the cooperation of other educational institutions, and some of the exhibits from the Hall of Science will be presented to these institutions. President Sproul's committee to assist the commission will distribute the exhibits to the seven divisions and the various departments of the university. They will be used primarily for teaching and research purposes.

AN expanded program of research in pulp, paper and related products is provided for in a new agreement entered into by the Federal Department of Mines and Resources with the Canadian Pulp and Paper Association and McGill University. According to *The New York Times*, under the terms of this agreement the association undertakes to provide greatly increased support for the extension of studies aimed at the improvement of production methods and the reduction of manufacturing costs. The first agreement for such cooperative activity was entered into twelve years ago, at which time the association erected a special research building on a site provided by McGill University. It is pointed out by the *Times* that McGill, as well as other Canadian universities, finds through the pulp and paper industries a broad field of employment for graduates in engineering, chemistry and related sciences.

DISCUSSION

PERCEPTUAL DISORIENTATION DURING LANDING OF AIRPLANE

IN October, 1937, when making a plane trip to Texas, I had a striking experience in disorientation. During the intervening three years, despite frequent recitals of the experience, I have found but one other plane passenger who has observed the phenomenon. The phenomenon, as occurring in the airplane setting, is unknown to several psychologists who have been approached. It is likewise new to several aeronautical experts who have been told of it—including the pioneer, William B. Stout.

An opportunity to check the experience came on October 6, 1940. It faithfully repeated. Only the second episode need be related here. This second experience took place while using a TWA plane from Cincinnati to Detroit—a daytime trip in clear, sunny weather. I sat alone, facing forward, in a front left-side seat, next to the window. There were no passengers across the aisle, and I thus had a clear view through the right-side windows also.

The plane came down to make the Dayton Airport stop. As it levelled off, the disorientation phenomenon faithfully repeated itself. That is, after the plane has come down to the edge of the field, and has started to skim along the runway, the phenomenon begins. Looking out of the left window (with my face against it) the level field appeared as it should appear—horizontal. Glancing quickly across the aisle to look at the field through the right windows, the field was not as it should be: it appeared to slope down forward at an angle of about 15 degrees.

For the next 2,000 or 3,000 feet of travel, while the plane flew (or later rolled) along the runway, I rapidly looked back and forth eight or ten times. In spite of knowing perfectly well that the ground on one side was a continuation of that on the other, and in spite of these rapid and repeated opportunities to compare the ground on the two sides, the ground to the left remained horizontal, and that to the right persisted with its forward downhill slope.

When the plane, with a low remaining speed, wheeled through a short turn to taxi back, the phenomenon abruptly ceased.

The explanation offered below finds approval among the psychologists approached so far. With my face against my left window, the frame of my window is too far beyond my angle of vision to be allowed to act as a frame of reference. Thus, as long as the plane does not go into acrobatics, and sticks to minor lateral shifts or makes gentle glides to airports, I am given a full chance to reorient the ground and agree with myself that it is still horizontal.

But in looking across the aisle, a different story is presented. In level flight, the fuselage of the plane is for a long time approximately horizontal; also, the window frame lines are then horizontal and vertical. In particular, the eye has observed that the top and bottom window frame lines are parallel with the horizon.

Then, after the plane has changed its angle for landing, the fuselage is tilted upward by perhaps 15 degrees. One's intelligence therefore tells him that the ground is still horizontal, and that it is the window lines that have tilted upward. But the illusion takes charge and remains in charge. The window lines, which had been horizontal, continue to seem horizontal; the ground takes the blame, and seems to slope. The effect remains until the plane stops, or makes a turn at the end of the runway.

For the passenger, this is just another curious psychological experience; but it is conceivable that for the pilot, it might on occasion mean disaster. In landing by instruments, instruments can fail; and a daylight visual landing might have to be made. What then? It may be that with all plane designs ever produced up to now, the pilot can remain free from the effect. But some new design, perhaps combined with incidental shutting off of forward vision by frost or oil on the windshield, might place the pilot under the necessary conditions. Resulting confusion could have serious results.

Until some one makes tests, it would seem that to avoid the trouble, cockpit windows should have curved frames, rather than rectangular. This suggestion grows out of what one sees from the left-side window of the incident described. In addition to seeing the ground, a large part of my visual field was filled with a view of the wing and the nacelle. Obviously, these parts did not cause disorientation, even though they, like the right-hand window frames, had changed angle with respect to the ground. These parts present only curved outlines. Therefore, it may be that with all frame-of-reference lines curved, the disorientation would not occur.

A. D. MOORE

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FROST RINGS IN LONGLEAF PINE

"FROST rings," abnormal zones of parenchymatous wood resulting from freezing temperatures during the growing season, are of common occurrence in northern and western trees.[1] To the writer's knowledge, however, their occurrence in longleaf pine (*Pinus palustris* Mill.) has not been previously reported.

Increment cores from second-growth stands of this species in southern Mississippi frequently have a conspicuous yellow- to tan-colored zone in the springwood of the 1932 ring. Microscopic examination shows the laterally displaced rays, distorted xylem elements and short-celled parenchyma that characterize frost injury. Weather Bureau records for Mississippi report the February of 1932 as the "warmest February in the records of this section beginning in 1888." The mean monthly temperature was 59.1° F., nearly 10 degrees higher than normal. This exceptionally warm period was followed by temperatures of 20° to 24° throughout southern Mississippi on March 9 and 10.[2]

Generally the injury is found in the beginning of the second or third ring from the pith, since usually only the 1- or 2-year-old shoots were affected. From 0 to 12 rows of normal springwood cells may intervene between the end of the 1931 growth and the frost ring, indicating the extent of growth previous to the period of freezing weather.

The malformation is present at breast height in most of the trees small enough to have been affected. Since second-growth longleaf is often marked by "false" rings and extremely narrow rings resulting from fire, the presence of a distinctive ring caused some years ago has been of service in growth measurements.

EARL L. STONE, JR.
SOUTHERN FOREST EXPERIMENT STATION

THE SUPERVISION OF PUBLICATION

DR. ATHERTON SEIDELL, writing in SCIENCE,[1] finds some fault with the distribution of scientific contributions among scientific workers in view of the difficulty and expense to which the worker is put in obtaining for his study the articles in which he is interested.

Dr. Seidell tries to criticize constructively, for he offers a recommendation for the solution of the problem:

> It is evident [he states] that a complete reorganization of the present system of publishing the results of scientific investigation is needed. Toward this end an advisory council on publication should be organized in each country for the purpose of studying the existing periodicals and defining more precisely the character of the contributions to be published in each. A system of routing the original communications in accordance with the field covered by each journal should also be established. The more highly specialized periodicals produced in this manner would enable the subscribers to receive more papers in which they are interested and fewer on subjects with which they are not concerned. The individual research worker would find it to his advantage to subscribe to them, and the cost of their publication would thus be distributed to an increasing extent among those for whose special benefit they are produced. ***The supervision of publication by a central agency in each country would probably result in the elimination of some journals*** [italics mine *sic*] and avoidance of the many changes in character, policy, title, size, price, etc., in others which now so greatly complicate the collection and maintenance of complete sets of periodicals by libraries and the task of making bibliographic searches in them.

Dr. Seidell, now with the U. S. Public Health Ser-

[1] A. S. Rhoads, *U. S. Dept. Agr. Bull.* 1131. 1923.

[2] U. S. Weather Bureau, Climatological Data, Mississippi Section, February, March, 1932.

[1] SCIENCE, 92: 345, 1940.

vice, and for forty years on the payroll of the government, describes the scheme one would expect of a Totalitarian State or the U. S. S. R. What is the country coming to when its servants in high places propose "central agencies" for sorting and distributing the "contributions of the workers" and "eliminating some journals" for the "advancement of science and the public welfare"? How about the public welfare being served by individual enterprise and the freedom of the press? Give me the horse-and-buggy days, and leave for Europe the advancement of State Socialism.

RICHARD L. SUTTON, JR.

KANSAS CITY, MO.

THE PLANNING COMMITTEE OF THE VIRGINIA ACADEMY OF SCIENCE

THE Virginia Academy of Science, with its thousand members from all fields of science and from prominent lay groups in the state, is to have a long-range planning committee to help make its usefulness to the state and nation more effective in these defense times and in the future. In addition, this committee will have a group of prominent Virginians as consultants, their names to be announced later.

The personnel of the long-range planning committee appointed by Wortley F. Rudd, president of the academy, follows:

Arthur Bevan, state geologist; L. C. Bird, president of Phipps and Bird, Inc.; Raymond B. Bottom, publisher of the *Daily Press* and *Newport News Times Herald*; Dr. Julian A. Burruss, president of the Virginia Polytechnic Institute; Francis S. Chase, executive secretary of the Virginia Education Association; Justus H. Cline, chairman, board of directors of the Virginia Wildlife Association; Virginius Dabney, editor of the *Richmond Times-Dispatch*; Dr. Frank A. Geldard, professor of psychology, University of Virginia; Dr. Meta Glass, president of Sweet Briar College; Dr. Sidney B. Hall, state superintendent of public instruction; Dr. William R. Harlan, assistant director of research, American Tobacco Company; Dr. J. Shelton Horsley, surgeon; W. Catesby Jones, chief chemist, State Department of Agriculture; Dr. Ivey F. Lewis, dean of the University of Virginia; H. K. McConnell, vice-president, Tobacco By-Products and Chemical Corporation; Robert F. Nelson, publicity director for the Virgina State Chamber of Commerce; Dr. Garnett Ryland, head of the department of chemistry, University of Richmond; R. M. Sanford, assistant director of the State Planning Board; Dr. I. A. Updike, head of the department of chemistry, Randolph-Macon College, with other officers of the academy besides Dean Rudd and E. C. L. Miller as *ex-officio* members; Dr. George W. Jeffers, president-elect and professor of biology at Farmville State Teachers College, and Dr. Sidney S. Negus, head of the department of chemistry, Medical College of Virginia.

This long-range planning committee will soon have its organization meeting and begin considering various scientific problems of Virginia which have been suggested during a comprehensive survey extending over the last four months and just completed. Some 1,200 persons were consulted by the president of the academy in this survey.

E. C. L. MILLER,
Secretary-Treasurer

SCIENTIFIC BOOKS

THE THEORY OF PROBABILITY

Theory of Probability. By HAROLD JEFFREYS. Oxford: published by the Clarendon Press. 1939.

THE purpose of this book is to construct a foundation for scientific method and to analyze inductive reasoning. The problem is attacked with the aid of the theories of probability and statistics. The author gives a set of postulates for the theory of probability. These postulates specify certain relations between implication and probabilities and demand that probabilities shall constitute a completely ordered set. Probabilities are interpreted as "degrees of reasonable belief" and are distinguished from the numbers which represent them. Number is introduced by means of two conventions and one additional postulate. These conventions do not require that certainty be represented by the number one. In fact on occasions the author finds it convenient to represent certainty by infinity. On the basis of the postulates and the conventions the usual results of the theory of probability are derived. The author discusses estimation problems and significance tests with the aid of Bayes's principle and the following rules: "If the parameter may have any value in a finite range, or from $-\infty$ to $+\infty$, its prior probability should be taken as uniformly distributed. If it arises in such a way that it may conceivably have any value from 0 to ∞, the prior probability of its logarithm should be taken as uniformly distributed." He devotes considerable attention to the justification of these rules. The latter part of the book is concerned with general questions, including a discussion of the frequency theory and other foundations for the theory of probability.

Let us note that science and indeed all inductive thinking are vitally concerned with predictions. The first few pages of this book furnish a strong support for this claim. In the pages which follow Jeffreys

develops methods for estimating our degrees of belief in such predictions, but he fails to show how these degrees of belief are related to the successes and failures (or anticipated successes and failures) of the predictions. This neglect is characteristic of those who interpret probabilities in terms of mental states. In fact, the objection to such an interpretation is that it tends to conceal this fundamental problem. This problem is important. For if degrees of belief should give no adequate characterization of anticipated successes and failures, then they could have no important connection with such successes and failures. Perhaps this seems trivial, but it readily follows that without such characterization degrees of belief would be of no importance in science or inductive thinking. Fortunately, however, it is possible to obtain a consistent non-trivial characterization of probabilities in terms of anticipated successes and failures. I have done this in an article published in *Erkenntnis*. In view of this possibility the above objection would not be serious if it were not for two additional difficulties. First, my characterization was accomplished with the aid of the statistical theory to which the author violently objects and, second, the failure to consider the question which I have raised has led to some very questionable reasoning in connection with the representation of certainty by infinity. It is of course conceivable that one could develop a theory of probability which was based on such an infinite scale and which contained a connection between probabilities and results. However, the author has not done this. Furthermore, in some applications of Bayes's principle he has used two different scales in the same problem without any interpretation or justification of the procedure. Thus in the case of problems of estimation we are left with formulas based on very doubtful prior probabilities. If this were the best we could do, we should have to be content. But Fisher and Neyman have developed corresponding formulas which are independent of the prior probabilities.

The author has tackled a problem which has previously received too little attention and much is to be gained by following his treatment of the subject. Thus my criticisms should be taken simply as indicating points that need further attention. The book is indeed a contribution to the advancement of science.

ARTHUR H. COPELAND
UNIVERSITY OF MICHIGAN

EUGENICS

Preface to Eugenics. By FREDERICK OSBORN. 312 pp. New York: Harper and Brothers, 1940. $2.75.

THE preface to eugenics is the set of principles and practices that must be adopted before "a eugenic form of society will be possible" (p. 260). This set includes: birth control, "equal opportunities for development open to all children everywhere." "Children have the right to be born to parents who will care for them properly. Children have the right to be born free of the more serious hereditary defects." The book under review is largely an elaboration of these points.

There are seven chapters. The first refers to chromosomes and genes, human variability and the need of improvement of the racial stock. The second is a keen and sound study of the hereditary and environmental factors in the psychological sphere. This is largely the work of Dr. Gladys Schwesinger. Chapters 3 and 4 deal chiefly with population and are largely quantitative; but reference is made to relative fecundity of whites and Negroes and that of various socio-economic groups. Chapter 5 deals with eugenic selection under the influence of a favorable environment and stresses the importance of birth control and especially the desirability of the reduction of births among those least responsive to the possibilities of their environment and the increase of births among parents who are most responsive. The author does not discuss the craving for children that exists among certain middle-class women like the mother of President Harding, who had eight children and stated that she wished she had had more. On the other hand, just as in Rome great prosperity resulted in reduction of fecundity among the "higher" classes, so prosperity seems to act in the United States. No subsidy would alter their attitude. Chapter 6 deals with the psychological aspects of a eugenical environment. This cites from Dr. Margaret Mead the case of two primitive peoples in one of whom the children are handled gently by the parents and become gentle; in the other the children are handled roughly and grow into hard and aggressive adults. The possibility that there is a genetic thread running through the generations that may be partly responsible for the difference is not discussed. In geese, living in flocks, the parental instinct herds the young from infancy and when they in turn become parents they herd their young. Is this merely a transmission of a tradition, or is there an hereditary factor? The author states that the ideal of equalizing educational opportunities in the United States has never been fully attained. He does not discuss the possibility that the inequality of opportunity is partly due to the inequality of the children for taking advantage of it. The author finds that the atmosphere of colleges and graduate schools is generally unfavorable to marriage. Perhaps there is a selection here such that the more marriageable are married before they get to the graduate schools. If, as the author concludes, "parents who want no more children should be helped not to have them, and par-

ents who want children should in most cases be helped to have them" then the career-seeking and the prosperous, the ambitious and educated would have even fewer children and the group at the opposite socio-economic scale would have more of them. A feeble-minded girl discharged from a state institution had 14 children, perhaps because she wanted them.

As a whole, the book is well and interestingly written. The principal criticism might be that the author tends to make generalizations which are the result of his profound conviction and reasoning, but for which the factual basis is often not given. Of the high idealism of the author there can be no doubt, but as to whether we should wait for the completion of the preface before beginning education in regard to mate selection and inheritance of traits there may well be a difference of opinion, and to many students the preface to the Preface would be more research.

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THE NATIONAL ACADEMY OF SCIENCES

ABSTRACTS OF PAPERS

(*Continued from page 458*)

Orthogonal polynomials and closure: JAMES A. SHOHAT (introduced by L. P. Eisenhart). The following two results are established: (1) If closure holds for a symmetric system of orthogonal polynomials (OP), it also holds for property related non-symmetric systems of OP, and *vice versa*. Illustration: the polynomials of Hermite and Laguerre. (2) If the remainder in Parseval Formula, applied to a given $f(x)$, is $O\left(\frac{1}{\log_n^{2+\epsilon}}\right)$, with some $\varepsilon > 0$, then the expansion of $f(x)$ in a series of OP under discussion converges almost everywhere in the orthogonality interval (a, b), assumed to be finite. This yields very general criteria of convergence, in particular, for continuous functions.

General invariants of irregular curves: EDWARD KASNER. The general group of analytic transformations is applied to curves expressed in fractional power series. Some types have invariants, some have not. This presents a new aspect of restricted topology. An extensive complete classification has been obtained with the collaboration of J. De Cicco.

A supplement to Ramanujan's identities: HANS RADEMACHER (introduced by L. P. Eisenhart). S. Ramanujan gave two identities which make evident certain divisibility properties of the number of partitions $p(n)$. If these identities are written in terms of the Dedekind function $\eta(\tau)$ they can be subjected to modular transformations. In this way we obtain new identities, which are noteworthy because of the occurrence of the Legendre symbol.

The evolution of a peculiar stellar spectrum: Z Andromedae: OTTO STRUVE and P. SWINGS. The new 82-inch telescope of the McDonald Observatory has been devoted, during the past year, to a study of a relatively small group of peculiar stars whose spectra can not be fitted into the continuous sequence of normal stellar spectra. One of the most remarkable members of this group is the variable star, Z Andromedae. It was discovered as an irregular star of variable brightness in 1901 and it was early suspected to be subject to eruptions similar to those of a nova. The latest eruption took place a year ago, with an increase in brightness from magnitude 10.7 to magnitude 7.9. Since then the brightness has slowly declined. This eruption was accompanied by changes in the spectrum. Near maximum light the spectrum was that of a P-Cygni type star showing lines of relatively low excitation (Fe II, Ti II, etc.), displaced toward the violet by amounts corresponding to velocities of expansion between 100 and 60 km/sec. Since the early summer of this year the spectrum has taken on an entirely different character. We recognize essentially four distinct sources of light: (*a*) a hot star presenting some of the characteristic features of Wolf-Rayet stars; (*b*) a cool, M-type, giant star forming a binary system with the hot star; (*c*) a tenuous nebula giving rise to forbidden and permitted emission lines of [O III], O III, [Ne III], [Ne V]; this nebula probably surrounds the binary system; (*d*) remnants of an expanding shell giving rise to a P-Cygni type spectrum of H, He I, Fe II and to emission lines of Mg II, Si I, Si II, Ti II, Fe I and [Fe II]. The occurrence of irregular violent outbursts in a binary system is of special interest. They are probably responsible for the enveloping nebula and for the disappearing spectrum of the expanding shell. The latter is remarkable because of the exceptional strength of the so-called forbidden auroral transition of [O III] at λ 4363. This line is also strong in several other binary systems of similar type, namely, in T Coronae, AX Persei, CI Cygni, RW Hydrae, etc. The effect is interpreted as a consequence of high electron density in the nebula—a phenomenon which we have also observed in the planetary nebula IC 4997. Z Andromeda bears a certain resemblance to the famous variable Mira Ceti, in which the hot binary companion is a variable emission-line star of spectral class B, and to Antares, whose hot companion is surrounded by a small nebulosity which exhibits forbidden lines of [Fe II]. It is exceedingly probable that the close association of a cool giant star with a compact, hot companion results in disturbances which we observe as eruptions, and which produce a succession of spectroscopic anomalies: an outburst of the surface layers of one of the two components, the gradual dissipation of the exploded material and, finally, the creation of a nebula surrounding the entire system.

Orbital motion in the multiple system Sigma Coronae Borealis: PETER VAN DE KAMP and JANET M. DEVILBISS (introduced by C. E. McClung). A twelfth magnitude

star sharing the proper motion of the well-known visual binary Sigma Coronae Borealis was discovered a year ago on plates taken with the twenty-four-inch refractor of the Sproul Observatory. The positions of the distant companion (c) and of the two components of the classical pair (A,B) were measured on 29 plates taken on 22 nights since 1916. The resulting relative motions were reduced to a reference frame of thirty-five faint stars. The relative proper motion of the faint companion c with respect to the center of a mass of A and B amounts to $+.''0004 \pm .''0023$ in right ascension and $+.''0101 \pm .''0023$ in declination; the errors include the accidental errors of observation and of the inertial system. Compared with the total motion ($0.''29$) of the system A,B the relative motion of c and AB is small enough to leave little doubt about the physical connection of c with AB. Interpreted as orbital motion, it is direct (counterclock wise), as is the relative motion of B and A. The separation of c from the center of mass of A or B is $632.''74$ in position angle 241°6′48″ (2000 equator). The yearly increase in position angle is $2.''8$; the direction of the relative motion differs 59° from the radius vector, which at present appears to be decreasing. With a parallax of $.''048$ (distance 68 light years) the projected linear separation is 13,000 astronomical units. In Sigma Coronae Borealis one thus finds a *quadruple* system, representing the widely different periods of eight days for the spectroscopic system A, about 1,200 years for the visual system A,B, and a period of the order of a million years for the motion of c around AB.

Some galactic explorations in the southern hemisphere: HARLOW SHAPLEY. The metagalactic survey of the southern sky, which is being carried on with the aid of the staff and various telescopes of the southern station of the Harvard Observatory at Bloemfontein, in the Orange Free State, has brought to light many interesting or peculiar objects not heretofore known. Among the items discussed are the following. (1) A new Magellanic Cloud in Phoenix, only twenty degrees from the South Galactic Pole, which is probably of dwarf galaxy type, at a distance of not less than a million light years. (2) Further exploration of the wing to the Small Magellanic Cloud that points in the direction of the Large Cloud and helps to establish the hypothesis that the Large and Small Clouds are a true double system. (3) A new globular cluster that possibly lies between our Galaxy and other members of the local group of galaxies. (4) A region in high galactic latitude that is devoid of faint variables and which indicates therefore the irregularities in the structure of the star haze surroundng our galactic system. (5) A peculiar streak nebula in the southern Milky Way that is somewhat similar to the well-known Veil Nebula in Cygnus. Not heretofore recorded, it is now found on several long-exposure plates, some of which show that its irregular arc is more than four degrees in length, and only about one thirtieth of a degree wide.

Quantum many-body problem: L. I. SCHIFF (introduced by D. W. Bronk). A method is developed to treat the quantum mechanical many-body problem at temperatures so low that degeneracy plays a dominant role. The inter-particle forces are taken into account in a manner analogous to the expension in virial coefficients of the equation of state of a non-ideal classical gas, while the degeneracy is always considered exactly. Thus the first term in the expansion gives an ideal Fermi-Dirac or Bose-Einstein gas, as the case may be, and not an ideal classical gas. The second term gives the correction due to two body encounters; it can be reduced to a set of quadratures if the wave-functions that describe the collisions of two particles are known. The method is now being applied to the phase transition in liquid helium, with the object of finding the nature of the deviations from London's free-particle model. It may also be useful in the theory of metals and of atomic nuclei.

A pragmatic approach to the elementary principles of wave mechanics: WILLIAM F. G. SWANN (introduced by D. W. Bronk). The paper proceeds by a route which does not involve, and has meaning apart from, the concept of charged particles. The starting concept is that of a state of a system, supposed defined by a function ψ of a number of variables, which for purposes of illustration is taken as 3. Two kinds of states are involved. We have states such as those of the hydrogen atom where there is nothing to be seen as associated with the state itself, and where the story of interest is in the transitions. Then we have states represented by what, in the ordinary descriptions of phenomena, correspond to such things as beams of electrons deflected in cathode ray oscillographs, but which in actuality present for observation beams of luminescence whose boundaries are to be associated with the boundaries between regions where ψ is zero and regions where it is finite. It becomes recognized that the shapes of such observable characteristics of a state can be described by a principle of least time, with a suitable chosen velocity μ, varying from point to point in such manner as to be proportional everywhere to $1/(E-V)^{1/2}$, where E is the potential difference which creates the beam, and V is the potential at a point between plates which deflect it, both being measured by voltmeters, for example. A recognition of the fact that a beam such as the foregoing can—in what are called electron diffraction experiments—become split into several beams suggests laws of interference such as demand periodic phenomena, and implies that the beams themselves are ray paths in a wave system governed by the velocity μ aforesaid. The ordinary diffraction experiments are usually regarded as establishing the law $\lambda = h/mv$, but confinement of attention to what is *observed* experimentally leads merely to a relation, $D \sin\theta = sg/E^{1/2}$, where s is an integer, D is the grating space, θ is an angle of deflection appropriate to the experiment, and E is the voltmeter potential difference which created the beam. The essential gift of experiment is to reveal the constancy of $E^{1/2} \sin\theta$ and so through the association of $D \sin\theta$ for $s=1$ with the wave-length λ, that quantity becomes determined as $g/E^{1/2}$ and the velocity μ for this case of zero V becomes determined in terms of the frequency ν as $\mu = g\nu/E^{1/2}$. Association of this result with the proportionality between μ and $1/(E-V)^{1/2}$ for the case where V is not zero leads to $\mu = g\nu/(E-V)^{1/2}$. With this μ

we write down a wave equation, and solving it for periodic solutions, we arrive at a Schroedinger equation from which ν has disappeared explicitly, and only the experimentally determined constant g remains. The equation then gives eigen-values proportional to $1/n^2$, where n is an integer, provided that V is taken of the form q/r, where q is any constant. If we associate the eigen-values with the excitation potentials W_n for hydrogen, we can determine the numerical value of q. Subsequent association with line spectra for hydrogen through the relation $\nu_{mn} = A(W_m - W_n)$ determines a new constant A, or, if we choose, a quantity $\hbar$, defined by q/A. The electronic mass, m, makes no appearance at any point in a non-relativistic formulation.

Experimental studies on the physiology of diving mammals: LAURENCE IRVING, P. F. SCHOLANDER and S. W. GRINNELL (introduced by M. H. Jacobs). Seals (*Phoca vitulina*), porpoises (*Tursiops truncatus*) and Florida manatee have been observed during experimental dives of 15, 3 and 15 minutes, respectively. Characteristics of external respiration were recorded on a respirometer showing ventilation, O_2 consumption and difference between CO_2 and O_2 exchange as a basis for examining the sequence of physiological adjustments in detail. The heart rate of seals decreases immediately after a dive to about 10 per cent. of its normal frequency and returns at once on emergence. The bradycardia in porpoises and manatee is not less than half normal. In the arterial blood O_2 is steadily depleted during a dive and exhaustion of O_2 marks the limit of a diving period. Lactic acid does not increase in the blood to any extent during the dive, but in the recovery period lactic acid floods the blood of seals and manatee, and its CO_2 content diminishes in proportion. Surprisingly little lactic acid was formed in porpoises. Periodic analyses of muscles during dive and recovery showed that the oxygen content, about 5 volumes per cent. before the dive, is almost completely reduced in five minutes, and is restored quickly in recovery. Lactic acid apparently increases little until the time when the myoglobin is reduced and then rises more rapidly to a maximum as great as 300 mg per cent. at the end. CO_2 content does not change in the dive, but diminishes after recovery starts, when lactic acid is still high in the muscles and is appearing in large quantities in the arterial blood. The abdominal temperature remains constant during a dive, but the muscle temperature decreases. In recovery the abdominal temperature drops. The temperature changes indicate diminished provision of heat to the peripheral muscles. Blood flow in the muscles, as indicated by an electrically heated resistance wire type of meter, diminishes promptly in the dive and recovers immediately after. Indications are for sustained flow through the brain. The combined observations fit a scheme of adjustment to diving in which blood flow decreases through the muscles, which are maintained at first by utilizing their intrinsic oxygen reserves, followed by resort to anaerobic formation of lactic acid. The small part of the circulation which is still maintained during the dive provides prolonged aerobic metabolism for a selected part of the tissues, and when the oxygen available from blood is expended the diving capacity is at an end.

Collection and analysis of fluid from single glomeruli and tubules of the mammalian kidney: ARTHUR M. WALKER and JEAN R. OLIVER (introduced by A. N. Richards). This investigation represents an extension to the mammalian kidney of the type of experimentation employed by Richards and his collaborators on the amphibian kidney. Certain technical difficulties having been overcome, it became possible to visualize tubules and glomeruli upon the surface of eviscerated anesthetized guinea pigs and opossums, to cannulate these units with a quartz pipette, and to collect sufficient fluid from them for quantitative analysis of protein, glucose and total molecular concentrations by ultramicro methods. The portion of the tubule from which fluid was collected was precisely identified by the maceration technique of Oliver. A series of thirty experiments has been completed. The results prove that glomerular fluid has the same glucose and total molecular concentrations as blood plasma and usually contains no protein, that glucose is reabsorbed by the proximal tubule, and that the total molecular concentration of tubule fluid does not rise until the proximal segment has been passed. These results are analogous to the localization of function which has been demonstrated in amphibia.

Relative overgrowth of the central nervous system in vitamin A deficiency in young animals: S. B. WOLBACH and OTTO BESSEY. Vitamin A deficiency in young animals (rats, guinea pigs, dogs) if established early, during the period of greatest growth rate, has as one of its striking consequences injury to the nervous system involving sensory and motor functions. The explanation has been found to be overgrowth of the central nervous system in relation to its bony enclosure, resulting in mechanical damage to brain, spinal cord and nerve roots. Our studies have been made chiefly upon white rats. In this animal the gross manifestations of the growth differential established by the deficiency are: (1) overcrowding of the cranial cavity with distortion of the brain, shown by dislocation toward the foramen magnum and extrusion of the cerebellum and cerebrum into the venous sinuses of the dura at the sites of arachnoidal villi; (2) overcrowding of the spinal canal with distortion of the caudal end of the spinal cord and herniation of nerve roots into the intervertebral foramina and into the bodies of vertebrae; (3) resorption of bone of the cranium and bodies of the vertebrae due to pressure. In the latter location deep pits, symmetrically situated and occupied by coiled nerve roots, are formed. In rats the unequal growth of bone and nervous system occurs between the fortieth and sixtieth days of age, a period in the deficiency when weight increase has been but little retarded. If vitamin A (in the form of carotene) is added to the diet at 42 days of age and the diet restricted in amount so that the growth parallels litter-mates in continued vitamin A deficiency, none of the effects described above takes place. On postmortem examination at sixty-three days of age, the rats given carotene show no, or very slight, ana-

tomical changes in the central nervous system, in contrast to the striking lesions found in the litter-mates maintained on the deficiency for the entire period. Growth of bone eventually ceases in vitamin A deficiency and this fact must enter into the explanation of the effect described. However, the study of rats whose growth has been retarded at an equal rate and degree—(1) through inadequate diet with full vitamin complement and (2) through riboflavin deficiency—showed normal relations of nervous system to skeleton. Guinea pigs in general responded to the deficiency, as did rats. One experiment with dogs indicates that the maximum effect in this animal will be found in cranio-cerebral relations. We are unable to explain satisfactorily this disproportionate growth established in young animals by vitamin A deficiency. In order to evaluate data on hand, a more complete knowledge of the growth sequences of the skeleton of the rat must be obtained. We are convinced that vitamin A deficiency does not retard the growth of the nervous system. Our studies thus far suggest that the most important consequence of vitamin A deficiency upon growth of the skeleton is upon those sequences concerned in the substitution of bone for cartilage—*i.e.*, endochondral growth of bone. Unretarded growth of the central nervous system and disturbances in initiation and development of centers of ossification are the two obvious factors to be considered in the search for an explanation of the effects we have described. These two factors, when considered in relation to normal growth sequences and anatomical differences of the several species exhibiting lesions of the central nervous system in consequence of A deficiency, may possibly explain the different effects thus far described in rats, dogs and calves.

(*To be concluded*)

REPORTS

THE NATIONAL DEFENSE RESEARCH COMMITTEE

DR. VANNEVAR BUSH, chairman of the National Defense Research Committee, has made public a list of scientific men and engineers who have thus far accepted definite appointments to work with the committee. The committee will deal with particular problems as they arise. Further appointments will be made as rapidly as effective use can be made of additional individuals in the solution of specific problems.

Created by order of the Council of National Defense on June 27, the National Defense Research Committee consists of the following eight members:

Vannevar Bush, *Chairman*, president, Carnegie Institution of Washington.
Richard C. Tolman, *Vice-Chairman*, dean of the Graduate School, California Institute of Technology.
H. G. Bowen, Rear Admiral.
Conway P. Coe, Commissioner of Patents.
Karl T. Compton, president, Massachusetts Institute of Technology.
James B. Conant, president, Harvard University.
Frank B. Jewett, president, National Academy of Sciences; chairman of the Board of Bell Telephone Laboratories.
G. V. Strong, Brigadier General.

The secretary of the committee is Dr. Irvin Stewart, director of the Committee on Scientific Aids to Learning.

Dr. Bush, as chairman, is coordinating the work of the committee with that of other governmental and private agencies and is maintaining direct supervision over a limited number of problems. General Strong and Admiral Bowen are responsible for the maintenance of close working relationships between the committee and the military services. Commissioner Coe is in charge of matters relating to inventions and patents and provides a direct connection between the committee and the National Inventors Council.

Dr. Tolman is chairman of the division dealing with armor and ordnance, Dr. Conant of the division dealing with chemical problems, Dr. Jewett of the division dealing with communication and transportation, and Dr. Compton is in charge of the work on detection, controls and instruments.

Professor Charles C. Lauritsen, of the California Institute of Technology, is vice-chairman of the division concerned with armor and ordnance. Those who have already accepted appointments to work on problems with which that division deals include:

P. H. Abelson, Carnegie Institution of Washington.
Samuel K. Allison, University of Chicago.
Ralph D. Bennett, the Massachusetts Institute of Technology.
Robert A. Becker, California Institute of Technology.
L. V. Berkner, Carnegie Institution of Washington.
Walker Bleakney, Princeton University.
John E. Burchard, the Massachusetts Institute of Technology.
Donald S. Clark, California Institute of Technology.
R. H. Crane, University of Michigan.
J. A. Fleming, Carnegie Institution of Washington.
Wm. A. Fowler, California Institute of Technology.
Ralph E. Gibson, Carnegie Institution of Washington.
R. H. Goddard, Clark University.
George Kenneth Green, Carnegie Institution of Washington.
L. R. Hafstad, Carnegie Institution of Washington.
C. N. Hickman, Bell Telephone Laboratories.
J. C. Hubbard, the Johns Hopkins University.
Emory Lakatos, Bell Telephone Laboratories.
R. C. Meyer, Carnegie Institution of Washington.
R. B. Roberts, Carnegie Institution of Washington.
H. P. Robertson, Princeton University.

H. D. Smyth, Princeton University.
John F. Streib, Jr., California Institute of Technology.
John T. Tate, University of Minnesota.
M. A. Tuve, Carnegie Institution of Washington.

Professor W. K. Lewis, of the Massachusetts Institute of Technology, and Professor Roger Adams, of the University of Illinois, are serving as vice-chairmen, under Dr. Conant, of the division dealing with chemical problems. Among those who are working with that division are the following:

Homer Adkins, University of Wisconsin.
W. E. Bachmann, University of Michigan.
J. C. Bailar, Jr., University of Illinois.
G. P. Baxter, Harvard University.
Henry Bent, University of Missouri.
Wm. Crowell Bray, University of California.
Weldon Grant Brown, University of Chicago.
Arthur M. Buswell, University of Illinois.
H. M. Chadwell, Tufts College.
E. W. Comings, University of Illinois.
G. O. Curme, Jr., the Carbide and Carbon Chemicals Corporation.
Farrington Daniels, University of Wisconsin.
Tenney L. Davis, the Massachusetts Institute of Technology.
B. F. Dodge, Yale University.
R. C. Elderfield, Columbia University.
J. C. Elgin, Princeton University.
Henry Eyring, Princeton University.
W. C. Fernelius, the Ohio State University.
L. F. Fieser, Harvard University.
Wm. Francis Giauque, University of California.
Henry Gilman, the Iowa State College.
C. S. Hamilton, University of Nebraska.
Henry B. Hass, Purdue University.
A. L. Henne, the Ohio State University.
Carroll Hochwalt, the Monsanto Chemical Company.
T. R. Hogness, University of Chicago.
Charles R. Hoover, Wesleyan University.
O. L. Hougen, University of Wisconsin.
C. C. Hurd, Northwestern University.
J. R. Johnson, Cornell University.
W. C. Johnson, University of Chicago.
H. F. Johnstone, University of Illinois.
F. G. Keyes, the Massachusetts Institute of Technology.
Morris S. Kharasch, University of Chicago.
Walter Raymond Kirner, Carnegie Institute of Technology.
G. B. Kistiakowsky, Harvard University.
Izaac M. Kolthoff, University of Minnesota.
C. A. Kraus, Brown University.
Victor LaMer, Columbia University.
Irving Langmuir, General Electric Company.
W. M. Latimer, University of California.
P. A. Leighton, Stanford University.
W. H. McAdams, the Massachusetts Institute of Technology.
W. L. McCabe, Carnegie Institute of Technology.
Duncan MacInnes, Rockefeller Institute.
C. S. Marvel, University of Illinois.
Thomas Midgley, Ethyl Gasoline Corporation.
C. R. Noller, Stanford University.
W. A. Noyes, Jr., the University of Rochester.
Linus Pauling, California Institute of Technology.
G. A. Richter, Brown Company.
W. H. Rodebush, University of Illinois.
W. C. Schumb, the Massachusetts Institute of Technology.
T. K. Sherwood, the Massachusetts Institute of Technology.
J. H. Simons, Pennsylvania State College.
G. B. L. Smith, Polytechnic Institute of Brooklyn.
George F. Smith, University of Illinois.
L. I. Smith, University of Minnesota.
Reston Stevenson, the City College of New York.
Charles A. Thomas, Monsanto Chemical Company.
Victor Howard Turkington, Bakelite Corporation.
E. S. Wallis, Princeton University.
Archie James Weith, Bakelite Corporation.
Albert Easton White, University of Michigan.
F. C. Whitmore, Pennsylvania State College.
Hobart H. Willard, University of Michigan.
E. B. Wilson, Jr., Harvard University.
M. L. Wolfrom, the Ohio State University.
J. H. Yoe, University of Virginia.
Don M. Yost, California Institute of Technology.

Assisting Dr. Jewett are three vice-chairmen—Dr. C. B. Jolliffe, of the Radio Corporation of America, in charge of communications; Hartley Rowe, of the United Fruit Company, in charge of transportation, and R. D. Booth, of the engineering firm of Jackson and Moreland, in charge of electrical and mechanical problems. Those who are assisting in the work of that division include the following:

Harry L. Bowman, Drexel Institute of Technology.
O. E. Buckley, Bell Telephone Laboratories.
Hallowell Davis, Harvard University.
J. H. Dellinger, National Bureau of Standards.
W. L. Everitt, the Ohio State University.
Harvey Fletcher, Bell Telephone Laboratories.
J. A. Hutcheson, Westinghouse Electric and Manufacturing Company.
L. F. Jones, Radio Corporation of America.
Vern O. Knudsen, University of California.
Frank H. Moore, formerly with the Tennessee Valley Authority.
A. F. Murray, consulting television engineer.
Haraden Pratt, Mackay Radio Company.

Dr. Alfred L. Loomis, of the Loomis Laboratories, is vice-chairman of Dr. Compton's division. Those assisting in the work of that division include the following:

Walter S. Adams, Mount Wilson Observatory.
Kenneth T. Bainbridge, Harvard University.
R. R. Beal, Radio Corporation of America.
Harold H. Beverage, Radio Corporation of America.
E. L. Bowles, the Massachusetts Institute of Technology.
Ralph Brown, Bell Telephone Laboratories.

S. H. Caldwell, the Massachusetts Institute of Technology.
E. U. Condon, Westinghouse Electric and Manufacturing Company.
Donald Cooksey, University of California.
C. S. Draper, the Massachusetts Institute of Technology.
E. W. Engstrom, Radio Corporation of America.
W. C. Evans, Westinghouse Electric and Manufacturing Company.
T. C. Fry, Bell Telephone Laboratories.
L. O. Grondahl, Union Switch and Signal Company.
William W. Hansen, Stanford University.
G. R. Harrison, the Massachusetts Institute of Technology.
Thomas H. Johnson, Franklin Institute.
M. J. Kelly, Bell Telephone Laboratories.
Paul Klopsteg, Central Scientific Company.
Ernest O. Lawrence, University of California.
Frank D. Lewis, Loomis Laboratories.
George Metcalf, General Electric Company.
J. P. Molnar, the Massachusetts Institute of Technology.
Philip McCord Morse, the Massachusetts Institute of Technology.
Edward J. Poitras, the California Institute of Technology.
Louis A. Turner, Princeton University.
Warren Weaver, Rockefeller Foundation.
H. Hugh Willis, Sperry Gyroscope Company.
C. L. Wilson, Research Corporation.

Serving on committees reporting directly to the chairman or otherwise assisting the chairman are the following:

J. W. Beams, University of Virginia.
Gregory Breit, University of Wisconsin.
Lyman J. Briggs, director, National Bureau of Standards.
T. H. Dillon (Colonel), Carnegie Institution of Washington.
Ross Gunn, Naval Research Laboratory.
John H. Howard, the Massachusetts Institute of Technology.
G. B. Pegram, Columbia University.
H. C. Urey, Columbia University.

Lloyd Sutton is serving on a Patent Advisory Committee with Commissioner Coe.

With the exception of six who have obtained leave of absence from their regular positions and who are devoting full time to the work of the committee, all have volunteered their services on a part-time basis without compensation. The committee has completed or has under negotiation approximately sixty contracts with industrial laboratories and universities for carrying out research on specific problems.

According to Dr. Bush, the scientists and engineers of the United States have been most enthusiastic in the offer of their services. In addition, they have understood that it is not possible on short notice to make the most effective use of the skill and talent of thousands of persons, and they have been sympathetic with the program of the committee in accepting the services of individual scientists only as problems were brought into a form where their talents could most effectively be used.

The task assigned to the committee by the Council of National Defense is that of correlating and supporting scientific research on mechanisms and devices of warfare. It does not extend to such matters as food or medicine and health. For that reason the men selected to aid the committee will continue to be drawn largely from the fields of chemistry, physics and engineering.

SPECIAL ARTICLES

THE LOGISTIC CURVE AND THE CENSUS COUNT OF 1940[1]

EARLY in 1920 Pearl and Reed[2] published the results of fitting a logistic curve to the census counts of the population of the United States from 1790 to 1910, inclusive. At the time the computations were made in 1919 the results of the census of 1920 were not available, and therefore were not and could not be included in the calculations. Soon after the original paper was published the notation was improved, and the curve took the definitive form, still, however, *without* the use of the 1920 count:

$$y = \frac{197.27}{1 + 67.32e^{-0.0313x}} \qquad (1)$$

where y denotes calculated population in millions, and x time, in base units of one year. This curve (1) will be hereinafter referred to as Logistic I. It is depicted graphically in Fig. 1 with the actual census counts of 1920, 1930 and 1940 (preliminary figure) inserted as crossed circles connected by a dash line to indicate that in the derivation of equation (1) no census count after that of 1910 was used.

Thirty years have elapsed since the last *datum* (the census count of 1910) available when the curve was calculated. It seems justifiable now to make a further examination of how the case goes, as was done in 1930.[3] The following tabulation gives the facts.

It thus appears that the forecast made by Logistic I missed the counted population by *16 parts in a thousand* in excess in 1920; by *2.5 parts in a thousand* in defect in 1930, and by *37.3 parts in a thousand* in excess in 1940. The error in 1940 is of perhaps about

[1] From the department of biology and the department of biostatistics (Paper No. 215) of the School of Hygiene and Public Health, Johns Hopkins University.

[2] R. Pearl and L. J. Reed, *Proc. Nat. Acad. Sci.*, 6: 275–288, 1920.

[3] R. Pearl and L. J. Reed, SCIENCE, 72: 399–401, 1930.

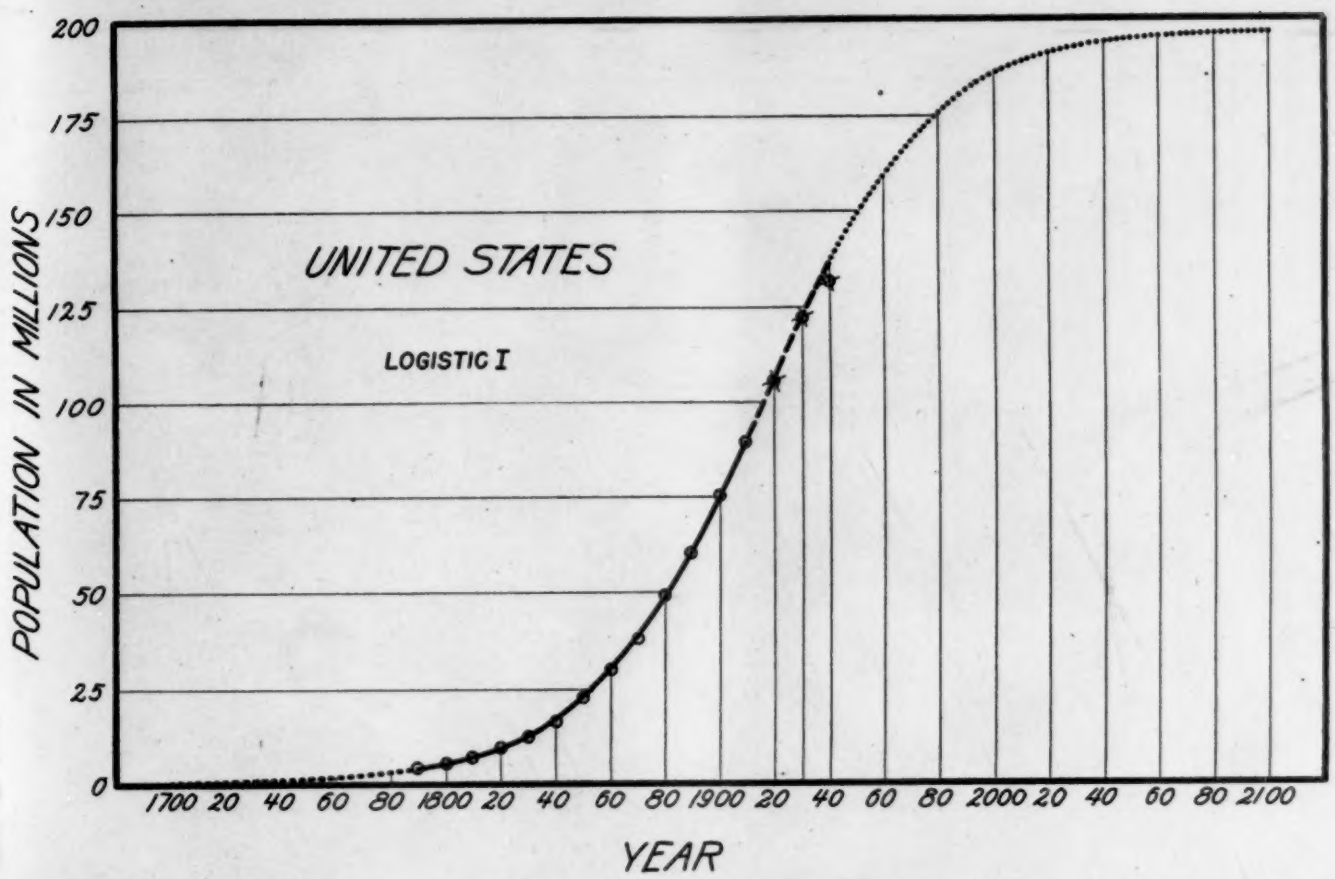

FIG. 1. The census counts of the population of the United States from 1790 to 1940, inclusive (given by circles). The smooth curve is the logistic of equation (1) fitted to the census counts from 1790 to 1910 inclusive. The broken lines show the extrapolation of the curve beyond the data to which it was fitted. The dash portion from 1910 to 1940 is the part of the extrapolation which has been tested by census counts (crossed circles) which have been made since the logistic was originally fitted. The dotted line shows the further extrapolation of the same curve.

TABLE I

POPULATION OF CONTINENTAL UNITED STATES (IN MILLIONS)

	A. As forecast by Logistic I (data of 1790–1910)	B. As counted by the Census Bureau
1920	107.4	105.7
1930	122.4	122.7
1940	136.3	131.4

the same order of magnitude as that probably inherent in the count itself. But it is considerably larger than that made by the curve in either 1920 or 1930.

In our earlier work with the logistic curve we have repeatedly emphasized (a) that it is a basic postulate of the logistic theory of population growth that any particular population can be expected to continue to follow in its later growth the same logistic curve that it has followed in its earlier growth *only* if there has been no serious or cataclysmic alteration of the conditions (climatic, geological, biological, economic or social) under which its earlier growth has taken place; and (b) that if, and when, evidence appeared that indicated that substantial alteration of the conditions of growth had occurred a new logistic should, and would, be derived to take into account the new evidence. The census counts of 1920 and 1930 indicated no such evidence. Does the count of 1940? We do

TABLE II

THE POPULATION OF THE UNITED STATES: (A) AS COUNTED IN OFFICIAL CENSUSES; (B) ACCORDING TO LOGISTIC II; (C) ACCORDING TO LOGISTIC I. (ALL POPULATIONS ARE IN MILLIONS OF PERSONS)

Year	A Observed	B Logistic II	C Logistic I	B–A	C–A
Lower asympt	....	.000	.000	....	....
1700	....	.210	.239	....	....
1720	....	.399	.446	....	....
1740	....	.758	.833	....	....
1760	....	1.438	1.553	....	....
1780	....	2.718	2.887	....	....
1790	3.929	3.730	3.929	− .199	.000
1800	5.308	5.108	5.336	− .200	+ .028
1810	7.240	6.974	7.228	− .266	− .012
1820	9.638	9.487	9.757	− .151	+ .119
1830	12.866	12.840	13.109	− .026	+ .243
1840	17.069	17.260	17.506	+ .191	+ .437
1850	23.192	22.997	23.192	− .195	.000
1860	31.443	30.294	30.412	− 1.149	− 1.031
1870	38.558	39.342	39.372	+ .784	+ .814
1880	50.156	50.209	50.177	+ .053	+ .021
1890	62.948	62.775	62.769	− .173	− .179
1900	75.995	76.684	76.870	+ .689	+ .875
1910	91.972	91.352	91.972	− .620	.000
1920	105.711	106.053	107.394	+ .342	+ 1.683
1930	122.775	120.054	122.397	− 2.721	− .378
1940	131.410	132.756	136.318	+ 1.346	+ 4.908
1950	.....	143.779	148.678	....	....
1960	.....	152.986	159.230	....	....
1970	.....	160.430	167.945	....	....
1980	.....	166.295	174.941	....	....
1990	.....	170.820	180.437	....	....
2000	.....	174.256	184.678	....	....
2020	.....	178.751	190.341	....	....
2040	.....	181.205	193.509	....	....
2060	.....	182.522	195.249	....	....
2080	.....	183.221	196.337	....	....
2100	.....	183.590	196.681	....	....
Upper asympt	.....	184.000	197.274	....	....

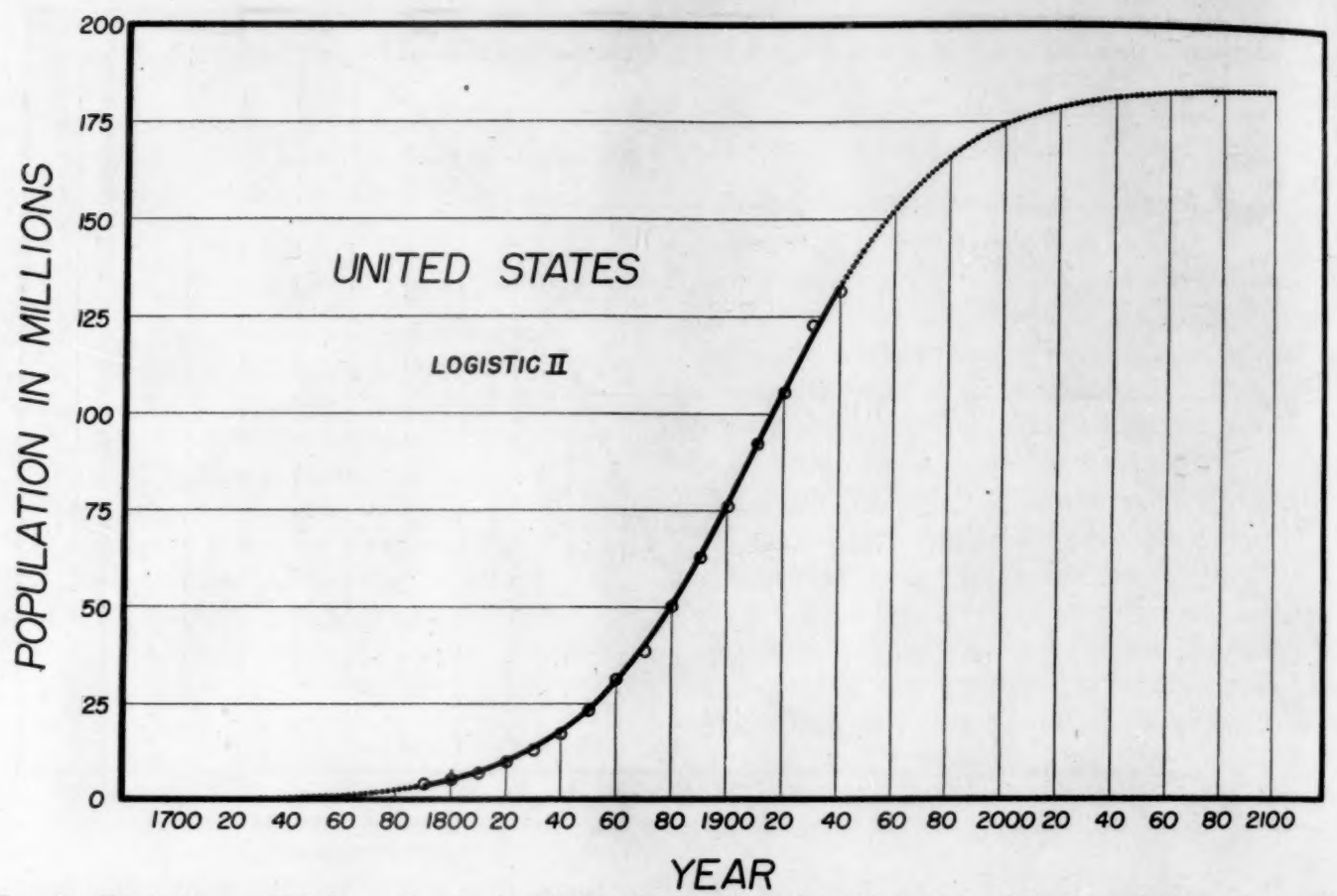

FIG. 2. Logistic curve II (smooth curve) fitted to the census counts (circles) of the population of the United States from 1790 to 1940 inclusive.

not know, and shall not know until the count of 1950 gives some indication as to whether the discrepancy between theory and observation in 1940 is merely a minor fluctuation that will be compensated for in the next ten years, or marks instead the beginning of a different trend of the curve.

But in the meantime, in part as a token of good faith relative to our past promises, we have computed a new logistic curve (Logistic II), using the method of successive least square approximations,[4] to the history of the growth of the population of the United States, including all the recorded data from 1790 to 1940 inclusive. The results are set forth in Table II, and Fig. 2. The equation of this new logistic (Logistic II) is:

$$y = \frac{184.00}{1 + 66.69e^{-0.0322x}} \qquad (2)$$

The constants K and C in (2) are *smaller* than in (1) by amounts that are respectively 6.7 and 0.9 per cent. of their values in (1). The constant r is *larger* in (2) than in (1) by 2.9 per cent. of its value in (1). From Table II the following root mean square deviations are computed

$$\sqrt{\frac{\Sigma(B-A)^2}{16}} = \sqrt{\frac{12.408}{16}} = .8805$$

$$\sqrt{\frac{\Sigma(C-A)^2}{16}} = \sqrt{\frac{29.853}{16}} = 1.3659$$

[4] R. Pearl, "Introduction to Medical Biometry and Statistics." Third Edit. Chapter XVIII *passim*. Philadelphia: W. B. Saunders Company, 1940.

It is plain that either of the two logistics fits the 16 observed populations very well, considering that each is only a three constant curve. But as to which makes the better forecast of the population to be counted in 1950 we are not prepared to say at this time. We hope to make a statement on the point in 1950.

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JOSEPH F. KISH

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THE HEPARINS OF VARIOUS MAMMALIAN SPECIES AND THEIR RELATIVE ANTICOAGULANT POTENCY

ON the basis of studies of impure beef heparin Jorpes[1] postulated that heparin is a mixture of mucoitin polysulfuric acids, the anticoagulant action of which is dependent on the sulfate groups, the potency increasing with increasing sulfur content. The isolation of the crystalline barium salt of heparin by Charles and Scott[2] has made it possible to prepare large amounts of the pure anticoagulant. Working with samples of this crystalline material isolated from different tissues of the ox, Charles and Todd[3] could

[5] Professor Pearl died on November 17.

[1] Jorpes, *Biochem. Jour.*, 29: 1817, 1935; *ibid.*, 33: 47, 1938.

[2] Charles and Scott, *Biochem. Jour.*, 30: 1927, 1936.

[3] Charles and Todd, *Biochem. Jour.*, 34: 112, 1940.

find no evidence of the heterogeneity claimed by Jorpes. Similar findings have been reported by Jaques and Waters[4] for the crystalline barium salt of heparin isolated from the blood of dogs in anaphylactic shock.

The latter authors reported that crystalline heparin isolated from dog tissue has a much greater anticoagulant potency than that from beef, suggesting a species difference. More recently, heparin has been isolated as the crystalline barium salt from pig and from sheep lung, and these also have been found to differ in potency. The potencies of samples of crystalline heparin isolated from the four species are listed in Table I. The anticoagulant in each case was purified

TABLE I

THE ANTICOAGULANT POTENCY AND SULFUR CONTENT OF HEPARINS FROM DIFFERENT SPECIES*

Source	Potency u/mg	S. content %
Dog	240	10.8
Ox	100	10.8(2)
Pig	44	10.4
Sheep	23	11.6

* In each case the potency reported is for the air-dried crystalline barium salt, while the sulfur content is for the same sample after removal of the water of crystallization (about 10 per cent).

and crystallized as described by Charles and Scott. The potency was determined by comparison with a standard preparation of pure beef heparin, using a modification of the Howell method. It is evident that heparin isolated from different species varies greatly in potency; *i.e.*, different heparins occur in different species. The barium salts of the various heparins all crystallize in the typical rosettes and sheaves described for beef heparin by Charles and Scott and apparently require almost identical conditions for crystallization. It is rare for a biological substance to show such widely differing activity in different species without a corresponding variation in crystalline structure.

The sulfur contents of the various heparins are also shown in Table I. While there are minor variations in these values, there is no correlation between the potency and sulfur content of these heparins. For example, as previously reported by Jaques and Waters, the sulfur content of dog heparin is no greater than that of the heparins from other species, although its potency is 2½ times that of the beef and 10 times that of the sheep heparin. Furthermore, in the 4 mammalian species studied, sheep heparin has the highest sulfur content and lowest potency. Hence, although removal of the sulfur inactivates heparin (Charles and Todd), the very high anticoagulant activities of the crystalline material from dog, beef and pork tissue must be due in part to factors other than the high sulfur content.

Investigations in these laboratories support the conclusions of Charles and Todd that the heparin in any one species is a chemical individual. It is evident, however, that different heparins are found in different species.

L. B. JAQUES

DEPARTMENT OF PHYSIOLOGY,
CONNAUGHT LABORATORIES,
UNIVERSITY OF TORONTO

[4] Jaques and Waters, *Amer. Jour. Physiol.*, 129: 389, 1940.

SCIENTIFIC APPARATUS AND LABORATORY METHODS

ELECTRO-FOLIAR DIAGNOSIS

WHILE investigating the alkalinity of greenhouse soils, caused by the use of hard water, and its relationship to chlorosis in plants, especially the role of iron and manganese as a cause of the chlorosis, the idea occurred that perhaps qualitative or semi-quantitative spot tests for these elements could be obtained by electrolyzing the leaf tissue and catching the removable ions in chemically treated filter papers. Accordingly, a suitable form of the well-known electrolysis apparatus was improvised which includes a common table clamp to hold the plant leaves, filter papers and electrodes, a 45-volt B-battery, a nickel crucible cover for the cathode, and a 1½-inch platinum disk for the anode. The general features of the apparatus are shown in Fig. 1.

The following technique was found suitable for the determinations: A plant leaf was perforated over an area of about four square centimeters by placing it on the convex side of a watch glass and tapping it with the teeth points of a fine comb. The perforated leaf was then laid between two small filter papers, which were saturated previously with a dilute acetic acid solution, and the whole then placed between the electrodes. After clamping the electrodes firmly together between insulators, and with suitable electrical connections, the current was passed through the leaf. Perforating the leaf in the manner described, and saturating the filter papers with an acid or salt solution, lowers the electrical resistance of the whole considerably and thus increases the efficiency of the electrolysis. Two minutes' time for current passage gave good tests for nitrates, phosphorus, iron and manganese in certain cases. Obviously, the proper kind of electrodes, current strength, chemical treatment of the filter papers and other experimental conditions to use will depend on the special tests to be made with the apparatus. In all cases, however, the filter papers must be free from the ions under test.

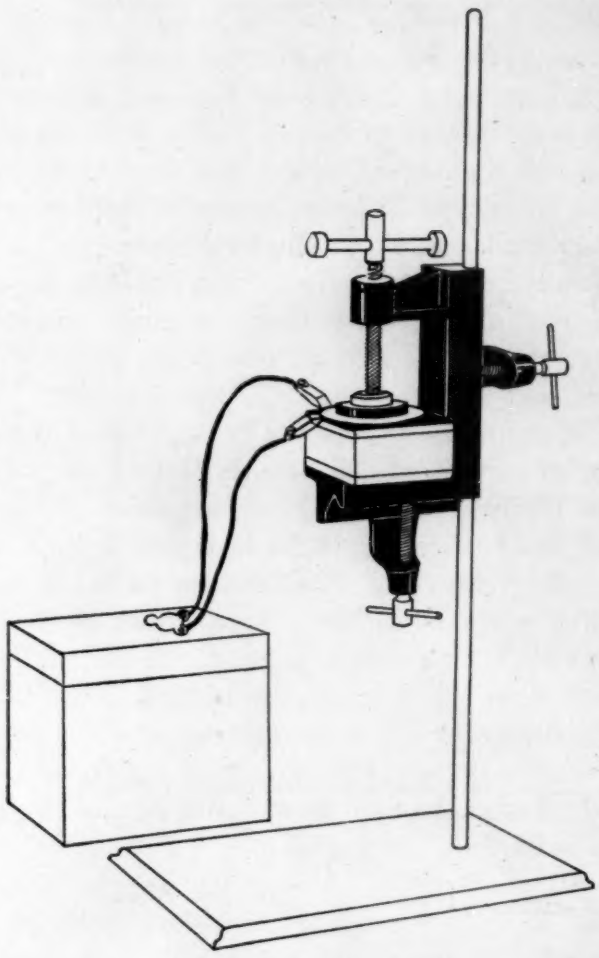

FIG. 1

The method is susceptible to various modifications. An important feature in its operation is the short distance of travel of the ions from the leaf to the papers, which reduces the time period required for a determination. Several papers may be used together when it becomes necessary to separate the testing operations, and one or more leaves may be taken depending on the amounts of the ions required for the tests. Paraffin rings on the papers confine the products of an electrolysis. Micro-cells may be formed by means of thin rubber gaskets. Black papers help to better identify white precipitates or light colored crystals under the microscope. Other modifications of technique may be necessary for special applications of the method.

Many important tests can be made with the method, and it should find a general application. In the field of soil fertility, diagnosis, problems pertaining to either deficient or excess plant nutrients, or to other chemical components of the soil, may be studied by means of rapid determinations of ions in the leaves of plants grown on the soil. Electrolysis of plant leaves should give information about the chemical processes and the physico-chemical states of the ions in the plant not obtainable by means of total analysis, the common method. Another possible use of the method is for the rapid detection of selenium, cyanide, arsenic, aluminum or other toxic substances which may be present in plants that have grown on certain soils.

Data are being collected for a more complete publication dealing with the application of the method to some phase of the general project as stated above.

C. H. SPURWAY

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A SIMPLE "LIVE" TRAP

AN ordinary spring mouse trap is fastened on top of a cigar box and strings tied at A and E (see Fig. 1). The hook at C is baited and a paper clip D is

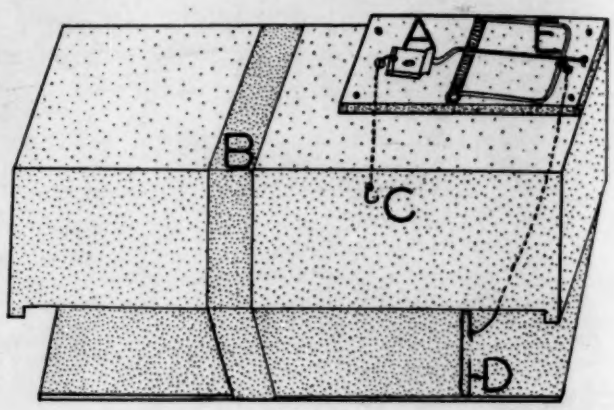

FIG. 1.

fastened to the end of the second string to hold open the lid of the box (placed upside down). A strong rubber band, B, is then placed around the box and the trap on top is set in the usual manner. When the prospective animal nibbles the bait at C the spring pulls the prop D and the rubber band quickly closes the box.

This type trap has been found satisfactory for small mammals such as field mice. By employing a larger box and modifying the bait hook it should be useful for larger animals.

If there is danger of surrounding twigs and grass springing the trap prematurely, a guard can be constructed of fine mesh window screen. Total cost per trap is approximately 5 cents plus 10 minutes' time for construction.

M. W. JOHNSON

DUKE UNIVERSITY

BOOKS RECEIVED

GLOYD, HOWARD K. *The Rattlesnakes; Genera Sistrurus and Crotalus.* Pp. vii + 266. Illustrated. Chicago Academy of Sciences.

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MITCHELL, LUCY S., ELEANOR BOWMAN and MARY PHELPS. *My Country 'tis of Thee; The Use & Abuse of Natural Resources.* Pp. xv × 335. Illustrated. Macmillan. $3.50.

STANFORD, E. E. *Man and the Living World.* Pp. xxviii + 916. Illustrated. Macmillan. $3.50.